Honeycraft

in

Theory and Practice

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IN THEORY AND PRACTICE

BY

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A Book of Principles—
"A plain *Because* for a plain *Why?*"

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PREFACE

THERE are signs that bee-keeping is " getting about again " after its long indisposition. Thanks to the lead given by the late Dr. Rennie, and the inspiration of Mr. Frow and his energetic prophet, Col. Howorth, it looks as if the old enemy, the " Isle of Wight Disease" (so called for want of a worse name), may now be relegated to history to " point a moral and adorn a tale."

To the author, that moral appears to be the necessity for every bee-keeper to know his bees and all that concerns them intimately and thoroughly. Bee-keeping is *a*—if not *the*—pursuit which best combines intellectual, useful, and profitable activities. Every movement and every development of a bee is a problem of intriguing interest, physiological, mechanical, psychological, many of them even now little understood, but all vastly entertaining.

It is in the hope of stimulating that interest and " blazing the trail " of experience that this book has been written. " Rule of thumb " methods do not pay: they are a loss to those nearest concerned, and a menace to their neighbours.

Swarming—that joy of the old and the despair of the new bee-keeper—has been treated simply and

in detail in order that the old as well as the new bee-keeper may realize that it is profitable, possible, and easy to prevent it by the timely union of knowledge with robust common sense.

To explain fully some phases of the text, a few illustrations have been borrowed from the works of standard authors and from dealers' lists, and grateful acknowledgments are hereby respectfully tendered for the privilege.

J. A. LAWSON, F.E.S.

"GREENACRE,"
FOREST ROW, SUSSEX.
April, 1931.

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PART I

THEORY

I

THE RISE OF THE HONEY BEE

In point of time it is difficult, if not entirely impossible, to say with certainty at what stage of the world's development the primitive bee adopted the habit of collecting and hoarding food supplies in excess of its daily needs. Students of evolution give reasons for believing that the *Apidæ*, to which family of insects the honey bee belongs systematically, took shape somewhere during the Cretaceous Period (roughly 60,000,000 years ago), and necessarily subsequent to or co-eval with the evolution of the flowering plant.

Historically, our first actual knowledge of man's domination and use of the insect appears to come by way of the literary references scattered through the early books of the Bible; in the age-dimmed pages of Homer, Aristotle, Virgil, Ovid, Pliny; and again in the sagas and legends of our mead-drinking Germanic ancestors.

Many centuries elapsed thereafter, however, before it could be said that man had begun to exercise a rational control of the bee's collecting and hoarding instinct.

The progressive stages of man's developmental partnership with the bee, from the lion's carcase in the epic of Samson to the modern scientific apiary, is a romance of most amazing interest.

II

HONEY

Its Composition

In its original state, as taken from the flower, honey nectar is a thin, watery fluid. It is sucked up the proboscis of the collecting (or field) bee and passed thence into the honey stomach for conveyance to the hive. Here it is regurgitated and delivered to the eager probosces of one or more of the younger bees (not yet old enough for field work), by whom it is deposited in the combs. After being changed about from one cell to another in the ripening process, it is finally sealed over with a thin flake of wax for storage.

As nectar is obtained from a great number of flowers of diverse families, scents, and habits of growth, it is to be expected that the composition of the resultant honey will not be chemically or proportionally uniform. Different races of bees (according to Prof. Dr. Zander) will even produce from similar nectar a quite different honey!

In the main, however, an average sample of

ripened honey may be said to furnish fairly definite proportions of

Water
Albumen
Fruit sugar (levulose) about 39·2%
Grape sugar (dextrose) about 34·7%
Cane sugar up to 10%
Gum
Pollen
Formic acid (taken as)
Digested fat
Lecithin
Volatile oils.

By the New Zealand "Sale of Food and Drugs Act, 1908," honey is officially described as:

"The nectar and saccharine exudations of plants, gathered, modified, and stored by the honey bee; it shall contain not more than twenty parts *per centum* of water, not less than sixty parts *per centum* of reducing sugars, and it shall not yield more than three-quarters of one part *per centum* of ash. It shall not contain any added sugar or glucose, artificial sweetening substance, added colouring matter, or other foreign substance."

What a pity our own authorities that be cannot decide and insist as definitely what we in England should consider honey! It would be better for the home producer and consumer—if worse for the retailers—if some of the "muck" one sees put up in gaudy packages and styled "Honey"—Empire or otherwise—was condemned by some such rule.

Its Uses

The chief use of honey nowadays is as a supplementary to bread; and to the majority of consumers it is difficult to imagine a more appetizing, agreeable, and health-giving delicacy.

The ancient, and even modern, writers credited it with most extravagant attributes both as a food and a medicine. In recent years, however, whilst experimental work on the science of food values has somewhat discounted some of the old beliefs, it has nevertheless put in their place a more explicit knowledge which cannot fail to be of service to the future producer and consumer alike.

In Sutherland's *System of Diet and Dietetics* the food value of honey is rated in calories at 100/125 per ounce, which thus ranks it as of equal sustaining power with milk, cream cheese, Gruyère and Cheshire, and egg yolk; ordinary jam being taken as 30/40, roast beef 60/70, Dutch cheese 80/90.

Further, as in the course of collecting and the processes of ripening, honey already has been digested by the chemical change of the cane sugar into invert sugar (levulose and dextrose), it possesses the advantage over fruit and other forms of sweetness in that it needs no further digestive effort. It passes direct into the system as a fuel and producer of heat and energy.

As a medicine, it is distinctly laxative and demulcent. It is used in many pharmaceutical preparations, officinal and otherwise, in ointments, cosmetics, and soaps.

A considerable quantity of the darker grades is

absorbed in the manufacture of confectionery, vinegar, mead, metheglin; and there appears to be a demand for it as a preserving liquid for some of the more delicate fruits.

Its Importance as a World Product

To the ordinary person honey production appears to be a sort of villager's week-end hobby; an odd job for old farm-labourers too decrepit to work.

A glance at the subjoined illustration, and a perusal of the following statistical figures, however, will show that in almost every country, honey production is becoming a serious and important occupation for a considerable part of the population, not merely as an agricultural side-line, but as a highly developed branch of skilled industry.

In the British Colonies and Dependencies, and the American States, bee farms of 1,000 hives are by no means uncommon. In the British Isles apiaries of hundreds of hives are not rare.

For the United States of America, it was estimated by Dr. Phillips (*Bee-keeping*, 1928 edition) that in the year 1919 there were 800,000 to 1,000,000 persons owning bees, and that the value of the honey produced, taken at wholesale prices, amounted to 30,000,000 dollars, and beeswax to about 2,000,000 dollars.

For the Fiscal Year ended March 31st, 1930, the total exports of honey from Canada were 1,710,055 lb. of the value of 175,807 dollars; of that amount 1,218,044 lb. came to England. (Figures supplied by the courtesy of the High Commissioner of Canada.)

In 1924, New Zealand had 6,174 registered apiaries of 79,000 colonies, and exported in that year (exclusive of that used at home) 1,025,584 lb. More recent figures (supplied by the courtesy of the High Commissioner for New Zealand) show the amazing growth and importance of the industry to the country, justifying to the uttermost the benevolent interest the Government has always shown to it.

1927	850,011 lb.	£25,170
1928	2,329,131 lb.	77,495
1929	2,365,887 lb.	82,743

Practically the whole of the honey exported was sent to the United Kingdom, although it is understood that a considerable proportion was afterwards re-exported to other countries (Scandinavia, Iceland, and Germany). 1930 has been a very bad year from the climatic viewpoint. The exports for the first seven months being down to 157,202 lb. valued at £5,790.

Australia in 1927/8 exported to Great Britain 242,176 lb. valued at £5,000; in 1928/9, 39,352 lb. valued at £730.

Spain, with rather more than 1,500,000 colonies, had a production of about £3,000,000 value of honey and wax.

Cuba in 1928 exported 3,837 tons of honey and 117 tons of beeswax.

Jamaica exported 800 tons of honey, and Palestine made an initial shipment of 5 tons.

In the British Isles, owing to the lack of legisla-

tive interest, such as is so bountifully given in the Colonies for this industry, it is impossible to give any official figures showing either the extent of ownership or the fruits of its toil. It is certain, however, now the acarine infestation is properly understood and its effects removed or mitigated by suitable treatment, that the industry will grow. If honey can be gathered and brought to our markets from the clover-fields of New Zealand and the sage regions of California and sold at a profit, surely there is enough forage in our own clover and sainfoin fields to warrant a successful expansion of honey production in the British Isles.

Its Sources

The honey-producing flora of a country is relative to its climatic and physical conditions as well as, to a considerable extent, the racial sources of the country's inhabitants. Speaking broadly, it will be found that wherever the Anglo-Saxon is the dominant race, the mainstay of his honey production will be centred in and around *Trifolium repens* (white clover) and other allied members of the great *Leguminosæ* family.

The finest grades of New Zealand honey, like our own, come from this source, as do those of Canada and Tasmania, while, speaking for the U.S.A., Prof. Phillips makes the remark: "It (white clover) is considered as a standard for comb honey, being equalled by no other source for this type of honey."

The Australian crop, as the noticeable exception, comes chiefly—but not entirely—from the indigenous

wattles and eucalypts; but, as the bush is cleared and the country further opened out for grazing, sheep-farming, etc., doubtless *T. repens* and its relatives will come into its Anglo-Saxon supremacy.

The British Standard Sources

The following brief tabulation of the more important individuals of our British nectariferous flora shows the extent of our reliance on the *Leguminosæ* as the source of our honey and pollen:

Order	Botanical Name	Flowers
Leguminosæ		
White or Dutch clover	Trifolium repens	May-Oct.
Red clover	Trifolium pratense	May-Sep.
Alsike clover	Trifolium hybridum	June-Aug.
Lucerne	Medicago sativa	June-Aug.
Horse bean	Faba vulgaris	
Bird's-foot trefoil	Lotus corniculatus	May-Sep.
Broom	Cytisus scoparius	May-June
Melilot	Melilotus officinalis	June-Aug.
Furze-gorse	Ulex Europæus	Jan.-Dec.
Compositæ		
Dandelion	Taraxacum officinalis	March-Oct.
Thistles	Cnicus and Carduus (various species)	June-Oct.
Knapweed	Centaurea nigra	June-Sep.
Ericaceæ		
Ling (Heath)	Calluna vulgaris	July-Sep.
Heather	Erica tetralix and cinerea	July-Sep.
Bilberry	Vaccinium myrtillus	April-June
Oleaceæ		
Privet	Ligustrum vulgare	June-July

Cruciferæ		
Charlock	Sinapis arvensis	May-June
Mustard	Sinapis alba and nigra	June-Sep.
Rosaceæ		
Apple	Pyrus malus	April-May
Plum and cherry	Prunus	April-May
Hawthorn	Cratægus oxyacantha	May-June
Blackberry	Rubus fruticosus	July-Sep.
Raspberry	Rubus idæus	June-Aug.
Aceraceæ		
Sycamore	Acer pseudo-platanus	May-June
Polygonaceæ		
Buckwheat	Polyganum fagopyrum	July-Aug.
Labiatæ		
Wild thyme	Thymus serpyllum	June-Aug.
Tiliaceæ		
Lime	Tilia vulgaris and platyphyllus	June-July

Flowers frequented chiefly for pollen

Salicineæ		
Willow-sallows	Salix caprea	April-May
Papaveraceæ		
Poppy	Papaver	June-July
Rosaceæ		
Dog rose	Rosa canina and varieties	June-Aug.
Meadowsweet	Spiræa ulmaria	June-Aug.
Irideæ		
Crocus	Crocus vernus	March-April
Lythrarieæ		
Purple loosestrife	Lythrum salicaria	July-Sep.

According to Mr. Herrod-Hempsall "the best honey for light and medium classes is obtained from white clover, sainfoin, mustard, turnip, and charlock; whilst for the dark classes, that from fruit blossoms, bean, blackberry, and buckwheat is the best. . . . The best granulated honey is obtained from clover, charlock, mustard, and turnip flowers."

III

HONEY PRODUCTION IN THEORY

First Steps

If the first references to honey in Genesis xliii-xliv may be regarded as historical, the exploitation of the honey bee's hoarding instinct must have been systematized by man at a very early date in his career. But whether he relied entirely on the haphazard methods of Samson, or on some initial stage of Virgil's equipment, we are not told. That old Father Israel, at a moment's notice almost, could direct his sons to make presents of "a little honey," appears to warrant the belief that by then man had developed some sort of theory of Honeycraft. And it is in the expansion and refinement of those crude early methods that modern man has become enabled in his turn to produce honey by the ton from a comparatively small number of hives, and to make a recognized profession of it.

As will be shown presently, the product of the early stages of Honeycraft was a very meagre one. It was not the fault of the bee. It—even the old black bee of our forefathers!—had all the elements

of greatness in it. Wisely directed, its 15 or 20 lb. instinct was capable of being expanded to vastly greater efforts.

It was mainly a question of the housing problem complicated by colonial development schemes, strangely reminiscent in a way of a phase of our modern social problems.

The ancient skep—like a typical slum dwelling—was quite unfit for decent family life. Damp and insanitary; unsuitable, home-made furniture; accommodation cramped—but why labour the parallel?

Scientific Developments

Honeycraft definitely became a science when, in 1851, the American, Rev. L. L. Langstroth, invented the movable comb hive (it is said that our own countryman, Maj. Munn, had already experimented in this line as far back as 1834 !), and so laid the foundation for all the later developments which have made the craft important as a world industry.

Personal Equation

Success in the production of honey in profitable quantities and qualities is probably more than anything else dependent on the personal equation of the producer. By this is meant that in order to secure the *greatest* success with bees, the producer should have a definite, innate sympathy with them—not that of the business man who looks on his hives only as an investment, but rather that of the

naturalist, the student who " constrains Nature to his will by obeying her." He will then be observant, patient, systematic, and careful of little things, all of which are of prime importance in the handling of bees.

It is by individuals of this type that the life of the bee has been intimately studied in health and in sickness, and to whom is due all the credit for the knowledge we possess of its physiology and habits, on which depends our ability to work the craft to the bounds of its possibilities.

Granted, then, personal fitness for the pursuit, the extent of the honey producer's success will be dependent on the following considerations:

Situation of the apiary and its relation to the adjacent flora;
Variety of stock bee and method of selective breeding for improvement;
Choice of equipment;
Knowledge of most up-to-date apiarian matters gained by study of best writers and current periodicals;
Business ability; and to some extent
Climate.

Situation of Apiary

The ideal position for an apiary would probably be in a quiet valley sheltered as far as practicable from north winds, and open to all the sun. It would stand well away from the public highway, but be within easy transport distance of some

populous district or railway convenience. The locality would abound in gorse and sallows and dandelions to supply fresh pollen for early brood-rearing. If possible, the flight radius (say, two miles) of the bees would include a few orchards of fruit trees. The neighbouring country would abound in clovers—the white or Dutch particularly; and if crops of sainfoin were grown for fodder within easy distance, that would be all to the good. If the sub-soil of the country was chalk, one would expect to find the slopes of the hills abounding with wild thyme, the lady's finger (*Lotus corniculatus*), and several of the thistles. In summer one might find good crops of the blackberry along the hedges yielding a fair crop. And in some parts of Britain it would not be found an impossibility to find within reasonable transport distance expanses of heather to which, in autumn, suitable hives might be taken to secure paying quantities of sections or pressed honey for the purchaser whose palate was strong enough to like it.

A certain amount of manipulative skill would be required in such a favoured district to keep separate the light and the dark honies; but this would be well worth acquiring to meet the varied tastes of consumers and present fashion.

In and around the sheep-farming counties similar conditions are to be found, and it is in these districts one expects to find the professional honey producer who harvests his 100 lb. and over per hive average, and reckons his season's take by the ton.

But it is to be noted such perfection is not

inseparable from profitable Honeycraft. Bees will work and flourish in the most unlikely situations. Indeed, they have even been known to realize quite a respectable surplus from a roof-position in a populous district of London.

It is probably safe to say there is not a district in the country where, in the average, knowledge and skill cannot keep the balance on the profitable side of a bee account.

Variety of Bee and Breeding for Improvement of Stock

The old English black bee of our forefathers served its turn well in the early days of the craft, but, like many another primitive type, it lost its identity in hybridizing with the conquering invader. As a pure strain, it has by now probably vanished completely, annihilated by the acarine infestation to which it was prone, or supplanted by natural selection.

In the finishing of sections, the old black had possibly no equal, the cappings being delightfully even and of a pearly whiteness.

It was not nearly so prolific as the continental races, however, and consequently, except in most favourable years, its surplus was never sufficient to warrant its retention as a commerical proposition, had it been possible to keep it pure.

Other of the black varieties, the Dutch, the French black, and the Carniolan, are still found in general use; but, although in the main they are docile, extremely good workers, and clean cappers, their

other natural qualities are not universally favoured for Honeycraft on an extensive scale.

It is to the yellow races the world of large honey producers has eventually turned, and in the Italian strain has found the ideal worker, docile, hardy, extremely prolific, and under proper manipulative methods, slow to swarm. So marked, indeed, is this latter characteristic that it is possible to build up and keep together in unity a colony of enormous magnitude, occupying six or seven stories of full-size brood-combs, and yielding hitherto unheard of quantities of merchantable honey.

By keeping careful records of the habits and production of each colony throughout the year, and rearing queens only from selected stocks, it is possible in time to build up a strain which will adapt itself to, and take fullest advantage of, the natural characteristics of any particular locality.

Haphazard and indiscriminate breeding is unscientific and wasteful. The best strains will quickly deteriorate under these conditions.

The secret of all profitable honey production is to keep stocks strong, headed by selected young, and highly prolific, queens, and to avoid swarming by the practice of modern manipulative methods.

Choice of Hive and Equipment

To make the fullest use of any selected strain of bee, it is necessary to have the most suitable equipment. As to the precise meaning of this, expert opinion is even yet divided. Practically every

bee-man—particularly of the older generation—has his own unalterable ideas on the subject.

The "W.B.C.," or double walled type, with its outer casing of removable lifts, has had by far the greatest vogue up to recent times.

The intervening, or dead air space (so called) between the outer cover and the walls of the brood and super bodies, was held to be an infallible insulator against extremes of heat and cold. That was its chief recommendation. In this uncertain climate, as a lodging for the old unprolific black bee, it did offer every advantage over the ordinary single walled hive except in the matter of price and, perhaps, portability. In the hands of such masters as Cowan and the B.B.K.A. experts of the end of the nineteenth century, it appeared to be perfection.

Nowadays, however, there seems to be a doubt as to the value of the insulation it provides in its "dead air" space. One well-known modern writer and large scale apiarian claims that by direct experiment he has disposed of its infallibility to preserve a uniform temperature, and claims greater efficiency with a 6-inch space. With this difference, however, he himself preserves the "W.B.C." idea in a hive he makes and recommends.

The after-effects of the acarine infestation and the almost universal adoption of the prolific Italian bee for large scale Honeycraft have, however, necessitated the introduction of a new technique of manipulation borrowed in the main from the Americans. And this, again, is re-acting on the choice of a hive most suitable for such manipula-

tion. This, undoubtedly, will be found to be closely related to the cheap, simple, and easily storified Langstroth type.

Size of Frame

It is not necessary at this point to open up the question of the most suitable size of brood frame. A wordy war on this subject has been waged by experts for years, and the last word appears to be that it is chiefly a matter of individual taste and manipulative skill. For the small producer and the ordinary bee, possibly the 14 inch by 8 inch British Standard frame is quite large enough. For the man who runs his hundreds of hives of pedigree bees, it is claimed with much reason that the Modified Dadant, $17\frac{5}{8}$ inches by $11\frac{1}{4}$ inches, or the Jumbo of the same size frame but greater number in the brood nest, is a saving of labour and an economy.

The Perfect Hive

It is the type of hive rather than the size of its frame that appears to concern us most at this point.

For successful modern honey production under the best conditions, then, the chosen hive must be of simple design; cheap to make and lasting; easy to move from one position to another; and all its parts interchangeable. It must be perfectly weather-proof and sufficiently insulated to withstand our winters; the insulation being necessary chiefly to prevent undue condensation of the natural moisture of the hive into active dampness. Bees can stand cold, but wet is fatal.

In a later section, the details of such a hive and

its fittings will be stated and carefully considered, both theoretically and practically.

Intimate Knowledge of the Craft

An examination of half a dozen representative books on bee-keeping, extending, say, over the last twenty years, will best demonstrate the necessity for the would-be successful honey producer to keep up with the stream of knowledge which continually flows in from all quarters of the globe.

As with so much more of our modern bee knowledge, it is to the American publications we are indebted for what we really know of the problem of scientific swarm control, around which, as a pivot, revolves the whole business of honey production.

Previous to the issue by Geo. S. Demuth, in 1921, of his "Swarm Control" (Farmers' Bulletin, U.S. Dept. of Agriculture), so little was definitely known of the contributory causes of a colony's disruption just at the most inconvenient time, that—important though it was—practically no two authors ever agreed in their explanations of the phenomenon.

Practically all felt that, as swarming was a natural law, it could not successfully be defied. Consequently all authors devoted their attention chiefly to what was best to do *after* the swarm had issued. There was general agreement that when run for extracted honey the colony was *nearly*, but when on sections it was *absolutely* certain to swarm, and our stock literature did not help us much to an understanding of just *why* this was so.

Simmins, possibly, came within close reach of the truth, and offered a solution, with some success, in a specially designed hive which, however, is little heard of nowadays.

Taking this as an example, it is to be noted that the world-wide dissemination of Demuth's analysis of the problem had its effect in every honey producing country. A new method of manipulation was evolved on its theses, and as a result, in the words of the author, "Swarming can now be controlled as effectively when producing comb honey as when producing extracted honey"—an issue of the very greatest moment to every bee-keeper.

Of really modern up-to-date books and periodicals there is fortunately no lack. Of the latter, our own *Bee World*, the official organ of the Apis Club, is a veritable fountain of the most recent world-wide bee knowledge, keeping pace with every development at home and abroad. The two well-known American monthlies, *The American Bee Journal* and *Gleanings in Bee Culture*, are available from English agents, and are well worth careful study.

Annual catalogues of supplies from the leading dealers and makers of appliances are of the greatest help in keeping one *au fait* with the latest inventions, and should invariably be applied for early in the year.

Remember "knowledge is power," and that the most up-to-date knowledge is the best.

Business Ability

In Honeycraft, as in any other competitive pro-

fession, there is need for most careful study and consideration, not only of producing, but also of selling and distributing the fruits of our labour to the best advantage. From our native flora we can produce the finest honey in the world. Having secured this, however, we are facing the problem of marketing it in competition with the enormous influx of first-class products from the Colonies and other countries. In the absence of facilities for co-operative grading and selling, such as make the honey producers' lot a comparatively light one in some of the Colonies, it is here that initiative and business acumen chiefly count.

As an example of what a properly organized system of co-operation can do for an industry, a careful examination of the closing pages of Bulletin 128 of the New Zealand Department of Agriculture is well worth while. It will answer the question that is often put to one, why, if English honey is the finest in the world, is it so rarely to be obtained in an average shop? You will see hundreds of New Zealand jars, but not often more than a dozen of English in the windows.

Had our own Agricultural Board been able and willing to organize and render assistance in one-half the measure that the New Zealand Government has done by its Acts and Regulations dating from the "Apiaries Act of 1908," the craft would not have been in the main a mere hobby, and the acarine plague a widespread calamity.

As it is, the individual honey producer in England has to face the competition of a world-wide, State-

controlled, and directed combination which, by persistent advertising and guaranteed excellence of its produce, has rightly gained the public confidence.

With this in view, the success of the English honey producer depends on his own efforts. If his bees are a hobby and a recreation merely, they are a deeply fascinating one and well worth while. If his bees are his livelihood, he can rest assured that his measure of prosperity depends on his individual knowledge and skill, and the intelligence and business acumen he brings to bear on his relations with the customers for his wares. He has nothing else to help him.

English honey will always sell when it is rightly produced and rightly offered.

Climate

Whilst adverse weather conditions are an undoubted factor in Honeycraft, it is extremely rare that, on the average, they are continuous enough in this country to prevent a favourable turn over. Taking one year with another, a well-bred strain of bees *under skilful manipulation* and care will always yield a profitable surplus.

"The winds and waves are always on the side of the ablest navigator," said old Gibbon; and although he was mainly an historian, he apparently had good "bee-sense."

In adverse conditions it is just on this point that profit or loss depends.

Our climate is notoriously so fickle, so dependent on the whimsies of Iceland and the Gulf Stream,

that it is on himself the bee-man must rely. It is fatuous to blame the weather if, in spring or after a spell of bad atmospheric conditions a colony is found to be too weak to make the fullest use of that period of settled conditions that follows as inevitably as night follows day.

As the bee-man masters the principles of his craft, theoretically and practically, he will pay less attention to the weather and more to the fulfilment of the golden rule of bee-keeping: KEEP YOUR STOCKS STRONG! And by so doing, he will prove that "every cloud has its silver lining."

IV

THE BEE

Physiological Considerations

If any moral is to be drawn from the painful and costly results of the twenty odd years of the acarine scourge through which Honeycraft in the British Isles has lately passed, it is that the attainment of a thorough and intimate knowledge of the anatomy and physiology of the honey bee should be the first duty of everyone who owns a hive.

If (in the light of after events) one reads back through the pages of the journals devoted to bee-keeping at the beginning of the "Isle of Wight Disease" invasion, and meditates on the display of ignorance which came from the pens of experts and amateurs alike which was offered up as knowledge, one is appalled. The remedies then suggested and the explanations given remind one forcibly of the time when "garden slugs gathered before breakfast and dissolved in new milk were a specific for consumption," and "a dead shrew-mouse hung by a silken thread around a child's neck was an infallible cure for whooping cough and croup!"

Just consider that we bee-keepers allowed seven-

teen years to be wasted—between 1904 and 1921—and hundreds, nay thousands of precious stocks of bees to die because there was not a man amongst us had the common sense and knowledge to do what Dr. Rennie and his assistants did—start investigations without a preconceived opinion that the trouble *must* be in the abdominal digestive and not in the thoracic respiratory system.

The humiliating remembrance of that ought to be a sufficient incentive to make every intelligent bee-keeper desire at least as much knowledge of the physical properties of his bees as of their collecting powers.

It is only by a thorough grasp of root principles that the activities of bees can be intelligently guided and controlled beyond the limits of their own age-long instincts. The "rule of thumb" man is a drag on the wheels of progress and a danger to his neighbours.

It is proposed, therefore, to devote the earlier section of this book to a concise statement of simple physiological facts and an examination of the relationship which exists between the bee and the flower in so far as they concern our subject of Honeycraft.

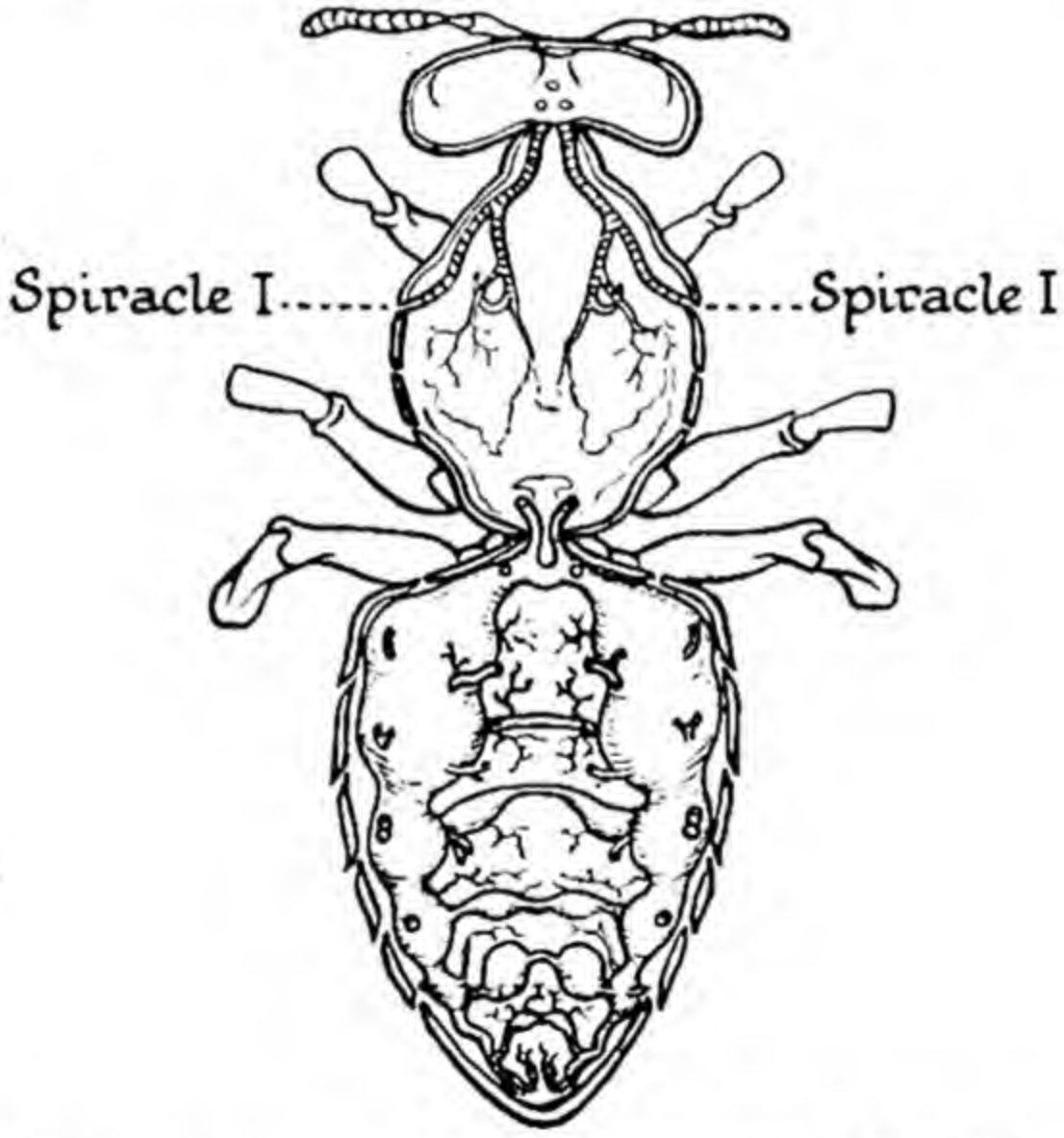
The Honey Bee

Of the numerous varieties of the species *Apis mellifica* known in various parts of the world, we need concern ourselves in this book only with the Italian, the Dutch, and the Carniolan. For the immediate present, moreover, the honey bee in

general will suffice to give us insight into the broad physiological details of the insect.

The Breathing System and Acarine Infestation

A study of the accompanying figure, which shows the breathing system of a worker bee, will enable one to follow with ease a description of the important process of respiration.



Thoracic tracheæ affected by acarine infestation.

In all animals it is necessary that the bodily parts should receive a constant supply of oxygen. In the higher forms of life this is drawn along with air into the lungs by way of the nostrils and wind-pipe, there to meet and oxidize the blood, and so be carried in effect to all parts of the system by the

muscular action of the heart. In the bee the same object is attained by other means.

If a bee resting after flight is watched, its abdomen will be seen to draw in and out in rhythmical motion.

A superficial examination will show that this organ is composed of six unequal pairs of horny overlapping plates; but actually to that number should be added another obscure part attached to the thorax, making in all seven external sections, with two additional pieces forming part of the sting. The thorax consists of three segments.

The abdominal plates are held together by a tough hingeing membrane, which allows considerable movement for the processes of respiration and food distension.

Breathing is carried on through a series of openings, known as spiracles, arranged in ten pairs around the lower sides of the thorax and the abdomen—three pairs in the former (one pair ineffective), and seven pairs in the latter. From these spiracular openings arise a series of tree-like branching tubes known as tracheæ which divide and sub-divide inside the body, extending in all directions in a network which penetrates and extends throughout the tissues. Connected with this tubal air system are numerous large air-sacs whose function appears to be that of the wind-bag of a pair of bellows. Respiration, according to an ingenious theory propounded by Miss Annie D. Betts, in her excellent *Practical Bee Anatomy*, apparently is worked as follows:

"The abdomen is expanded, pulling open the spiracles, and air flows into the sacs. The abdomen now starts to contract, slackening the spiracular muscles and closing the spiracles. The air cannot escape elsewhere, so is obliged to flow forward into the thorax and head. It mingles with fresh air drawn in through thoracic Spiracles I and III, and oxygenates the brain and lateral pharyngeal glands; finally it passes out down the tracheæ to Spiracle I, escaping there to the exterior."

The more practical part of this dissertation is its bearing on the grave subject of acarine infestation.

As must be well known to every bee-keeper, this most destructive complaint is due to the invasion and lodgment of a fertile female mite, *Acarapis woodi* (so named by Dr. Rennie, its discoverer), within the thoracic tracheæ of the hive bee, entrance having been obtained at Spiracle I. Inside this short length of tube, perhaps one-tenth of an inch long and the thickness of a stout hair, so microscopic is the mite that as many as a hundred of the individuals have been found living at one time, in all stages from the egg to the parent.

Acarapis woodi, in the adult female, attains a maximum length of ·007 inches. It belongs by relationship to that group of animals known as the *Arachnida*, which contains such varied forms as spiders, scorpions, cheese-mites, and ticks. It is very closely related, both in structure and looks, to the mite which causes itch in humanity, the cheese-mite, and the mite found as a parasite on beetles and humble bees—the chief difference being in

their methods of breathing. It possesses four pairs of claw-ended limbs (three pairs in the larva), and its mouth parts are slender, hollow, and needle-like, serving both to pierce the air-tube and to suck the blood of its victim.

It is in the first simple length of the trachea, whose opening is Spiracle I (see plate), that infestation occurs, and it is therefore by way of this opening that the invading mite makes its initial entrance. In very far advanced cases, however, infestation may occasionally spread into the smaller branches of the trachea.

With the exception of the first two pairs of spiracles (I and II) all the rest are provided with a kind of optional safety lock. Under just what circumstances this apparatus is used is unknown; but apparently it has hitherto proved a check on the entry of any smaller edition of mite into the abdominal air passages. According to Dr. Rennie, the abdominal spiracles are too minute to permit the passage of an adult *Acarapis*.

Spiracle II is functionless, but Spiracle I is partially concealed by a rounded lobe of the bee's outer casing. As this, again, is covered with a dense coat of hairs, it is interesting to speculate just how the original patriarch (or matriarch) mite, which founded this order of tracheal dwellers, managed to find its exploring way into what has proved for its posterity a veritable "promised land."

In the official publication of his research and discovery of the cause of the infestation (Bulletin 33

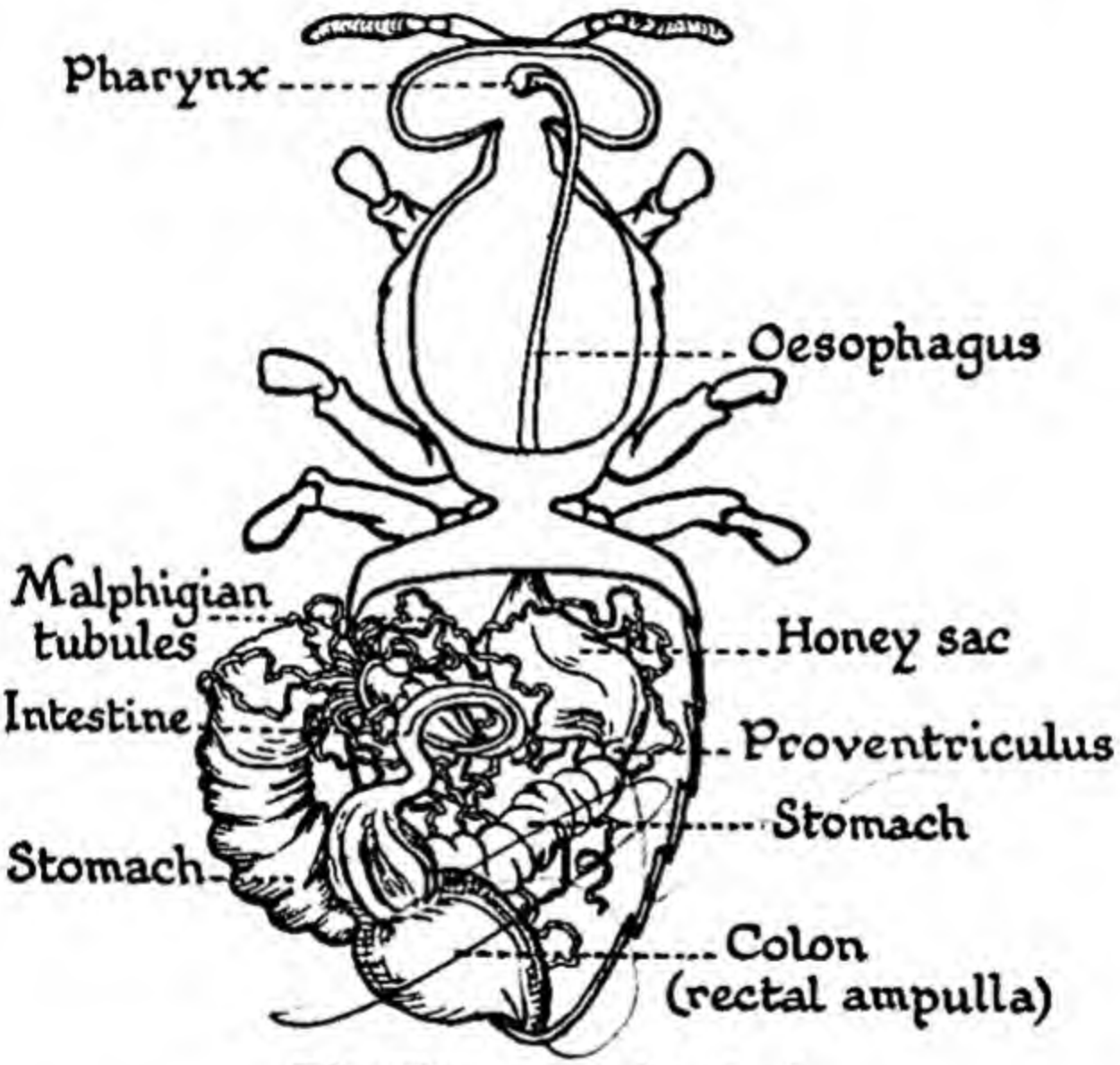
of the North of Scotland College of Agriculture—"Acarine Disease in Hive Bees, its Cause, Nature, and Control"), Dr. Rennie provides an ingenious hypothetical solution to this speculation.

Considering the lowly position in the animal scale occupied by this mite, he thought we might exclude conscious intelligence as much as blind chance from playing any part in the beginning as well as now. Although without direct experimental proof, he offered the suggestion that most probably an odour is exhaled from Spiracle I in the course of respiration, and that the mite has the capacity to respond to it. On the basis of this hypothesis he devised an experimental treatment for the extirpation of the pest, and this, with various modifications (to be described in a later section), has proved so efficacious that the acarine infestation has now lost its terror and bids fair to become a thing of the past whenever bees are treated rationally.

The Digestive System and Its Relation to Nosema and other Abdominal Diseases

It has been customary in the past when describing the digestive system of the honey bee to speak of it as analagous to that of the higher vertebrates. This, apparently, is somewhat too superficial in the detailed light of modern research. According to Dr. Phillips, such terms as "chyle stomach" and "large intestine" are quite unwarranted in "up-to-date bee talk." "Ventriculus" and "rectal ampulla" are offered instead as being a fairer description of their functions.

Taking the digestive system of the bee in terms of succession, and with just sufficient simple detail to suit our purpose, it may be noticed that the mandibles, or horny jaw parts, used in the biting and gnawing of solids, seizing the leg of an enemy bee, and laming the wing joint of a discarded drone,



Digestive system (worker).

as well as being used in the domestic function of wax manipulation, are situated on the sides of the mouth and in front of the base of the proboscis. They differ considerably in the three types of bee, both in shape and size. Those of the worker are gouge shaped, smooth and rounded; whilst those of the queen and drone are pointed and notched.

In all cases they work sideways, and not up and down as in the human face.

The proboscis, used in the collection of liquids, is a somewhat complicated piece of mechanism, well worth careful study. For our present purpose, it may be described cursorily as a flexible hair-fringed plate stiffened down the centre by a hairy rod, the edges gathered inwards and meeting together along its length to form a suction tube.

Nectar, collected by the spoon-shaped tip of the *glossa*, or tongue, is probably drawn through the length of its temporary groove by the sucking action of the pharynx (or mouth cavity) and so into the œsophagus. This organ, as will be seen by reference to the accompanying plate, occupies the whole length of the thorax, entering the abdomen by way of the narrow waist or petiole. Here it expands into the honey stomach or crop.

Up to this point the canal described may be looked upon as being specially devoted to collecting and transporting the nectar from the flower to the hive. There is no evidence of any provision for the exercise of the digestive function in its walls.

Between the honey crop and the succeeding length of the digestive system—the ventriculus (or mid-intestine)—exists what is known as the proventriculus, a narrow flexible constriction with an interesting reputation.

Previous to the investigations of Snodgrass (the well-known American researcher, whose *Anatomy and Physiology of the Honey Bee* is world famed), it was believed that the proventriculus was capable

of being pushed forward through the honey stomach into the hinder end of the œsophagus to allow of the digested contents of the mid-intestine being regurgitated at will as food for the larvæ. But this ingenious theory is now discredited as a mechanical impossibility. Apparently it is merely a valvular adaptation to prevent the raw nectar from passing beyond the collecting and transporting reservoir, from which it is regurgitated into the storage cells of the comb. That, however, in nowise detracts from the interest of it.

Beyond this valve is the ventriculus, a heavily ringed muscular organ of considerable length. The inner face of this organ is coated with a much folded and contorted lining membrane, the function of which is believed to be to produce some of the digestive juices or enzymes. It appears that, whilst honey is digested in the stomach, and probably pollen also, the products of digestion are not absorbed into the system until they reach the next stage of their journey—the small intestine. This organ follows the narrowing down of the ventriculus (as shown), and its contents discharge into what is variously styled the rectal ampulla, rectum, colon, or large intestine.

Just at the junction of the ventriculus and the small intestine may be noticed a thick fringe of hair-like tubes, one hundred or more—the Malphigian tubules—which appear to act as excretory organs and rid the blood of waste matters, pouring them into the intestine to be expelled with the fæces.

The structural adaptation of the large intestine

to the circumstances of bee life is as interesting as it is important. If the abdomen of a worker is dissected in spring before it has taken its first flight, this organ will be found to occupy by far the greater portion of the abdominal cavity. It is bloated almost to the point of bursting. Considering that, in a normal winter, bees may be confined to the hive for several weeks without an opportunity for flight, and remembering that digestion is a constant function, and that with the honey bee there is no such thing as complete hibernation, the importance of the intestine's vast expansibility to accommodate the products of this long accumulation of fæces cannot be overstated.

The bearing of this on the importance of proper food supplies for wintering on is very apparent, dysentery and death being the frequent penalty of neglect.

As the respiratory system has been shown to be the harbouring place of the acarine pest, it may be explained here that the digestive system is the resort of some of the more dangerous of the diseases of adult bees.

The most serious of these ailments at the present time is what is known as nosema disease. This, and an infection of the Malphigian tubules, are due to the presence of microscopic animal parasites, whilst bee paralysis, paratyphus, and possibly May pest, are apparently due to poisoning by bacteria, moulds, or fermentation. According to Miss Betts (*Practical Bee Anatomy*) poisoning may also be caused by fungi, and in this connection she gives

a timely warning against the practice of giving bees excessively mouldy combs to clean up!

The Sexes and Sexual Considerations

So far we have dealt on broad lines with the bee in general, without regard to sex or its implications. Now we come to a point where the line of continuity must be taken into account.

A profitable colony of bees in the season of its greatest activity consists of a queen, 50/70,000 workers, and a certain number of drones, consistent mostly with the skill and knowledge of the owner.

A glance at the accompanying plate will make clear their outward differences.

The Queen

As will be seen, the *Queen* is by far the largest of the three types. A perfect female, she is normally the mother of every individual in her colony. Her fecundity is so great that, in the height of the breeding season, a really good queen will lay between 1,500 and 2,000 eggs per day for a considerable period of favourable weather, and so sustain that enormous population which, in the care of the skilful apiarist, makes Honeycraft a profitable activity.

The development of the queen is one of the many amazing episodes of insect life.

The egg from which she is hatched in no respect differs from any other of the thousands laid by the mother, which, in the ordinary course of events, will produce just workers—imperfect females—and, as we shall see later, drones also!

If the egg is deposited in a worker cell, and is allowed to develop there, its full course will occupy twenty-one days from the laying of the egg to the emergence of the insect. If, however, the colony wills it, that same egg, by a special course of treatment, will produce in sixteen days, instead of the worker, a perfect female which, in the natural course of events, it is estimated may lay 1,500,000 eggs!

How is this seeming miracle accomplished?

Both the worker and the future queen start their career as a fertilized egg which the mother queen, by means of her long body, has introduced into the depths of a cell and there left standing upright, fixed in place by a gummy secretion.

The egg itself is sub-cylindrical and white, about one-sixteenth inch long, slightly curved, thicker at one end than the other, and its membranous surface is somewhat ridged. It is always fixed with the head of the future larva upwards. As in any other egg, it contains the nucleus, a surrounding layer of protoplasm, and a generous store of yolk as food for the developing embryo.

In three days the formless contents undergo a marvellous transformation. The linkage of the male and female gametes have started in motion the bounding energy of life, and the primitive cell proceeds by repeated division and re-arrangement to shape the parts of the embryo. The rudiments of the antennæ, mouthparts, head, legs, appear in due order, and inwardly the nervous and alimentary systems begin to develop and form.

In three days the embryo breaks its outer casing and helplessly faces its fate as either a potential worker of neuter sex or as the fertile mother of thousands.

Incidentally, to save misconception, it may be explained here that the egg predetermined for the queen is not normally laid in a worker cell. Under the swarming impulse a queen cell is usually prepared in advance and the egg laid direct in it.

The same procedure is adopted when a colony is preparing to supersede a failing queen.

It is in the case of urgent necessity, such as when the reigning queen dies or gets lost accidentally, that the egg or young larva in the worker cell is chosen for royal advancement, and the acorn shaped cell built round it.

The central point to be emphasized, however, is that the normal *fertilized* egg is the beginning of worker and queen alike, and from this fact has been evolved an ingenious system of producing queens at will by the professional queen-rearer.

To return to our newly hatched larva or grub—a legless, wingless, eyeless piece of naked helplessness, little else but stomach. If it has been predestined for a queen, its food throughout its whole larval career will be the rich, completely predigested "royal jelly." In this food, lavishly supplied from the "lateral pharyngeal glands" of the young nurse bees during the four days of its feeding stage, the larva bodily wallows. So enormous and swift is its growth that, according to data quoted by Dr. Phillips, its relative weight increases from 0·100 to

157·642 millegrammes within the short period of five days.

An analysis of the larval foods is quoted by Dr. Phillips, showing that whereas the one fed to the queen is more or less uniformly

Proteids	45·15
Fat	13·55
Sugar	20·39

that given to the drones and workers varies from the third day, being then mixed with honey—digested pollen grains and honey in the case of the former, and honey only in the case of the workers—giving analyses varying greatly from the queen food. And, remarkable though it may seem, it is just this difference in the food which is responsible for the stunting of the growth of the worker's sexual faculties and the stupendous development of the queen's.

This is proved by the practice of the skilled queen-rearer, who lifts ordinary worker larvæ into artificial queen cells supplied with "royal jelly," and produces first-class queens by the score almost at will.

On the ninth day from the laying of the egg, the mouth of the queen cell is sealed up by the workers with a porous capping, and the larva enters on that most amazing metamorphosis which, on the sixteenth day, ends in the emergence of the perfect insect. At the appointed hour, under normal conditions, she will cut with her powerful mandibles a

neat slit almost (but not quite) around the capping, and as she puts pressure on the inside, the circular piece springs open like a hinged lid, and she steps out.

For five or six days (under ordinary conditions) the young queen (or " princess " as she is sometimes called) will walk about the combs, feeding at intervals from the cells of unsealed honey, and gaining strength and confidence. Then one day, when the sun is shining and the weather is suitable, she will walk out, shyly and hesitatingly, to the front of the hive sometime between 11 a.m. and 3 p.m., and take her first flight. For a few times she circles about the hive, head towards it, storing up memories of her surroundings. Gaining confidence, she will presently dart away on swift wing up, up into the ether, far away out of sight; returning after her flight straight into the hive.

For a longer or shorter time she will do this each day until, having met a drone, she will come back to the hive a fertilized queen, to spend the remainder of her days in the humdrum task of egg-laying, her youthful romance ended.

The Worker

Almost from the moment she quits her cell, the *Worker* is a slave to duty. By the mysterious forces of evolution she has been led to sacrifice her sex and all that it implies for the good of the community as a whole. So blind is her devotion to the hive spirit that in the rush of harvest her average span of life is limited to a hectic five or six weeks!

This does not necessarily mean that by then her bodily constitution is worn out. Her life is bounded by the wear and tear on her wings.

It is a pathetic sight to watch her as, with tattered wings and hairless thorax, she pauses a moment on the alighting board before setting out for her last flight. All the golden glory of her sprightly youth is gone, all freely given for the benefit of the generations she will never see. Her hesitation is surely retrospective, and, laggard at last, she rises with an effort into the air and vanishes.

From the second day after leaving the cell, the young worker bee takes up the inside work of the hive. As nurse, she feeds and cares for the larvæ; supplies the queen and drones with prepared food; cleans and ventilates the hive; removes the dead; builds combs.

It is not until the workers are between a week and a fortnight old that they make their acquaintance with the outside world. On a warm day, about noon, they will appear almost suddenly at the front of the hive, and, after scuffling about in great excitement for a few seconds, they will launch themselves into the air. For a short time they will fly backwards and forwards about the hive, round and round, up and down, circling and gliding in youthful exuberance of life. It is their "playtime," and most evidently they enjoy it as such. It is always a temptation to dabble one's hands in the happy turbulence of their frolic! Suddenly they flop to the alighting board and vanish into the darkness, sobered and ready again for duty.

The beginner—and the old hand too, for that matter!—often feels just a touch of excitement in mistaking the play hour flight for the beginning of a swarm. But it all ends as suddenly as it began, and that is the difference.

From the age of fourteen to twenty-one days, the worker commences its field duties. The communal life of the hive is a many-sided service. Apparently no individual aims at being a specialist, but in response to some system or orderly sub-division of labour, it changes its duties as often as occasion demands. Nectar, pollen, propolis, and water form the harvest of its toil; but in exactly what way the thousands of workers choose their duties to keep a satisfactory balance is as yet a perplexity to the student.

It has been noticed that when a worker bee leaves the hive it does not exhibit any doubt as to what its object is. There is no vacillation in its movements. If water is its objective, it flies off to the nearest supply, fills up its honey stomach, and returns, prompt and business-like. If the sweet-scented racemes of the sycamore are swaying in the soft May sunshine, the bees know it, and like swift bullets they speed sure and straight from hive to tree. Notice the first heads of clover opening some dewy evening, and then watch the first flight of bees the next day. How do they know so promptly?

Gaston Bonnier, a French writer on bees, in 1906 made an ingenious attack on the problem by postulating a special intelligence department of searchers which, he claimed, went out early morn-

ings with the express object of providing prompt bulletins of the state of the countryside. His account of the experiments he made to support his theory makes the explanation feasible, at all events.

It appears certain that the work of the hive is conducted intelligently, and that it is not just lucky chance that prevents the worker frivolling its time away in butterfly-like hopping from one species of flower to another. Admitting just sufficient exceptions "to prove the rule," one may say that the bee which begins its collecting trip on clover will end it on the same flower.

If a bee is relieved of its "pollen-ball" on the alighting board, and the mass is gently stirred up in a drop of water and a sample put under the microscope, it is almost the rule to find the grains uniformly from one species of plant. One might find varieties of the species included, but rarely a different genus of plant.

It is just this characteristic which makes the hive bee of such priceless value to the fruit-grower. Were it otherwise, it is quite easy to see that the cross-fertilization of plants would be a matter of luck rather than the practical certainty it is, with all that implies from a scientific point of view.

Before leaving the worker bee, there is one peculiarity which may be mentioned with profit because of its bearing on the problems of breeding.

It has been said that the worker bee is sexless, neuter, a potential queen sacrificed to the service of the race. This is true in the main. Ordinarily

a worker exhibits no outward evidence of the presence of sexual organs, although under the dissector's scrutiny it is seen that those do exist in a rudimentary or reduced form.

Under certain conditions of the hive community, this link with the past comes into prominence, and organs which appeared to be merely evolutionary rudiments become stimulated into activity and life.

If a hive has been queenless for a considerable time, and there have been no larvæ young enough for the colony to rear a queen from (say up to three days old), there will almost invariably appear amongst them what is known as one or more "laying workers." By some means, the rudimentary ovaries of these freaks develop energy, and the phenomenon arises of an unfertilized and imperfect female laying eggs which will produce male offspring.

One theory to account for the laying part is that, when the colony becomes aware of its hopeless condition, a panic-stricken attempt is made to put matters right by feeding some of the youngest workers on "queen food," and this super-food develops and stimulates into activity their ovarian rudiments. There is this fundamental difference, however: whereas the paired ovaries of a queen each contains about one hundred and eighty ovarian tubes, those of a "laying worker" are limited to about twenty.

To pursue this question brings one "willy-nilly" to the subject of parthenogenesis—that is, the ability of an unfertilized female to produce young; and as

the existence and history of the drone is an instance of this, it will be better to discuss it under that head.

The Drone

The *Drone* is that big burly fellow who normally begins to "throw his weight about" in late April, and after leading a gay life of eating and drinking and daily aeronautics in the sunshine, is shown the door by his industrious sisters at the end of July, and dies from lack of nourishment—a victim to the rationalization of industry.

Fatherless from the beginning (his nearest male relative his maternal grandfather), the child of either queen or worker, and yet no queen or worker can be produced without him! What a complication!

As the freak child of a "laying worker," he yet apparently may be as fit for full fatherhood as the legitimate son of a queen, albeit he is much smaller of build by reason that his cradle was a worker cell and not a drone's. The cell of a worker, by the by, is about one-fifth of an inch; that of a drone about one-quarter of an inch in diameter; whilst that of a queen is about five-sixteenths of an inch.

The theory of the drone's amazing development from an unfertilized egg was first described by Dzierzon (pronounced Tiertsone) in 1845. The terms of his announcement fell under two heads:

(1) That the queen lays at will either male or female eggs, the latter being fertilized as they are laid, the former being laid unfertilized.

(2) That all eggs in her ovary would normally produce males, and if they are fertilized they will turn to females.

Apparently this hypothesis gave rise to a lot of heated argument amongst contemporary zoologists; but generally speaking, it was and is accepted as a true explanation of the drone's biology. Dr. Phillips modifies the second postulate as a result of his observations into " all of those eggs laid by a drone-laying queen which develop and become drones." He has found, he states, " that many eggs laid by a drone-laying queen fail to hatch, and are often removed by the workers in a short time."

On the other hand, our own countryman, Mr. Barrett, the well-known queen-rearer, has described in recent years a method of the artificial insemination of new-laid drone eggs by which one may produce queens almost at will. Apparently in his experiments he was not troubled by " dummy eggs," and his description of his operations leaves little room for doubt of the finality of Dzierzon's hypothesis, unless Dr. Phillips means that the same " dummy egg " would still be a " dummy " after it had been presumably fertilized by contact with spermatozoa. He certainly adds: " The potentialities of the eggs which never hatch are not known."

Just whether the queen can lay male or female eggs *at will* is a point which is not yet absolutely clear. One line of argument relieves the queen of any choice in the matter, the difference in size between the drone cell and the worker's making the

fertilization of the eggs automatic. The narrower cell of the worker causes a greater flexion on the queen's body when probing down it, which in turn causes an escape of the stored up male element in the queen's spermatheca, and a corresponding fertilization of the passing egg. The drone cell is so wide that the flexion is not necessary. Dr. Phillips counters this with the remark: "Since fertilized eggs may be laid in comb foundation when the side walls are only started, and since drone eggs are often laid in worker cells, this simple explanation cannot be accepted"; which certainly seems final enough.

In any case, the point which most concerns the practical bee-man in connection with the drone's parthenogenetic biology is the unchallenged fact that a pure Italian queen crossed with an alien drone will produce *hybrid female issue*, but *drones of her own pure Italian strain*. A matter of first grade importance to the queen-rearer.

Stages of Development

Before leaving this section the following table may usefully be recorded for reference:

Stage	*Queen*	*Worker*	*Drone*
Egg	3 days	3 days	3 days
Larva	$5\frac{1}{2}/6$ days	6 days	$6\frac{1}{2}$ days
Pupa	$7/7\frac{1}{2}$ days	12 days	$14\frac{1}{2}$ days
	16 days	21 days	24 days

It is to be noted that the figures may vary slightly with the weather conditions, hot weather accelerating and cold weather retarding development.

V

THE FLOWER

AN examination of the broader principles of Honey-craft would not be complete without some passing reference to the sources of nectar and pollen, so intimately is insect and botanical life dependent on each other.

The publication by Charles Darwin of his great work, *Cross and Self-Fertilization in the Vegetable Kingdom*, in 1857-8, focused attention on the fact of the close relationship which existed between the two kingdoms of life. In that book Darwin demonstrated the fact that a considerable number of plants had become entirely dependent for their fertilization on pollen being transported from one individual to another.

On this foundation of knowledge, zoologists and botanists have since built up a narrative of most fascinating interest which reads like a romance. In such books as Lubbock's *Relation of British Wild Flowers to Insects* and Kerner's *Plants and their Unbidden Guests*, in addition to a host of modern works on the same subject, one can follow the lines of development and evolution along which

for vast ages plants and insects have travelled in mutual interdependence.

For the benefit of the non-botanist, it may be explained that pollen is the male element necessary for the fertilization of the female ovule in the flowering plants, corresponding with the spermatozoa and the egg in the sexual mechanism of animated nature. It is to the necessity for the bringing together of these elements in the vegetable kingdom that we owe all the beauty of scents, design, and colouring of flowers, and the provision of that nectar which is the basis of our Honeycraft.

Amongst quadrupeds and bipeds, the sexes can seek each other over long distances during the breeding season. The drone bee can mount upwards into the sky in pursuit of the virgin queen. The salmon and the trout can come up rivers and perform their functions in convenient reaches. But, because of their inability to move by even a few inches of their own volition, a vast section of plant life has had to evolve a scheme of " go-betweens " to attain the same object.

That " Nature abhors self-fertilization " was an aphorism which arose from Darwin's studies of plant life. Whenever through force of circumstances and heredity an individual species is found dragging on its existence habitually by this method of perpetuation, one finds it characterized by inconspicuous flowers and commonplace vegetation—fecund enough, perhaps, but an outcast of its race in fact. In this category one may witness such

plants as groundsel, chickweed, shepherd's purse, etc.

A glance at the countryside in June will reveal a panorama of endless diversity in plant form and colouring. What strikes the non-botanical observer first, possibly, is the fact that the vegetation appears to fall naturally into two well-defined groups—plants with flowers (meaning those with coloured petals or sepals) and plants without flowers (meaning the grasses, the sedges, and the majority of our trees and bushes). Except for such forms as ferns and mosses, this is scarcely a true comparison, however. The real difference is not in the flowers themselves, but in the plants' use of them.

An actual flower consists of the central part—the ovary (the pouch containing the seeds or ovules), the style (the slender rod arising from it), and the stigma (the sticky end)—which unitedly compose the female portion of the flower; the male part being the anthers (those bags of pollen mounted on thin stalks which together are known as stamens), which are usually found clustering around the central style.

The coloured petals (or sometimes sepals, as in the marsh marigold and the hyacinth) are neither more nor less than advertising signs put out by the plant to draw the attention of insects to its pollen supply.

Actually a grass or an oak tree has flowers just as much as a rose or a foxglove. The distinction, then, between the groups of plants is somewhat wider than would appear superficially. Closer examina-

tion will show the difference to lie in the methods adopted for securing what we have already mentioned as "cross-fertilization."

As we have already mentioned, the range of plant life appears to fall naturally into two great sections, which are classified by botanists respectively as *Anemophiles* (Greek *anemos*—the wind) and *Entomophiles* (Greek *entomos*—an insect)—wind lovers and insect lovers, from the habits of their fertilization.

The first of these, the *Anemophiles*, which includes most of our trees, grasses, and sedges, our oaks, ashes, elms, firs, pines, hazels, wheat, barley, oats, for some reason best known to their remote ancestors, climatic or otherwise, chose the wind as their "go-between." Producing their pollen at a convenient season, they hang it out in exposed positions to be carried away and blown haphazard into the meshes of the feathery and sticky stigmas of their distant kith and kin. The pollen in this case is smooth, powdery, and adapted in every way for "air transport."

The other great section, the *Entomophiles*, with which Honeycraft is chiefly concerned, is distinguished by the possession of coloured petals and varied scents, and is at once the source of our nectar and pollen. In this group we find specialization to a definite partnership with insects carried to its farthest limit. Indeed, to such an extent has it been taken, that many plants removed from the range of a certain insect are unable to set their seed at all.

It is interesting to note, however, that this

FAGUS SYLVATICA
(Beech)

Male

Female

PHLEUM PRATENSE
(Timothy Grass)

Types of anemophilous flowers (wind fertilized).

specialization is not confined solely to the plant side of the partnership. There is plenty of available evidence to show that the evolution of these plants and insects has proceeded through time with the closest regard to their mutual needs. In fact, so striking is this, one might almost say that, in a complete review of our flowering plants, one could find specific adaptations to the needs of the whole range of visitors from the tiniest midge, through the beetles, butterflies, moths, bees, and even up to certain birds which unconsciously exchange their aid in pollination for the nectar and pollen they take from the plant.

In the whole range of botanical study there is no more entrancing and intellectual diversion than to take the various orders of our own flora and trace through their ingenious adaptations for pollination and the relation between them and insects. To catch and pin or press and dry specimens of insects and plants and arrange them in shrivelled up rows under labels is poor interest beside the study of the living individuals. The sepulchral cabinet is a cheap exchange for the vital knowledge one can get from this intimate friendship with Nature.

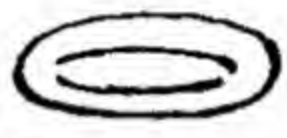
As one unriddles the uses of their amazing mechanisms, and reads from the rudiments and structural inversions the way of plant evolution, one grasps stronger and clearer the great principle of Darwin's Natural Selection, which changed so completely the whole course of scientific thought.

A few of the many ingenious principles adopted by plants for the transfer of pollen from one to

WHITE CLOVER

(Pollen)

APPLE



3 Grooves

DANDELION

WILD THYME

6 Grooves

Types of entomophilous flowers (insect fertilized).

another by means of insect visitors may be mentioned: the "piston" apparatus in the pea family (the vetches, lupins, bird's-foot, trefoil, restharrow, etc.); the "hammer" form of mechanism in the salvias; the "percussion" form of pollen-throwing in the corydalis; the "sprinkling" movement of the yellow rattle and toothwort, and again of the heath and borage; and the ingenious affixing of the pollinia in orchids to the probosces of bees—all are worth examining!

Of more practical interest to Honeycraft now comes the question: "What is there about pollen which makes it of such interest to the bee?"

Physical Properties of Pollen

Since pollen has been shown to be of such vital importance alike to plants and bees, it may be well in the interests of Honeycraft to go more carefully into its physical properties. We see it coming into the hive in the form of compact balls and cakes of many colours, carried on the corbiculæ of the bee's third pair of legs. It may also happen that, if the insect has been working on broom, its hairy coat will be smothered so thickly in the deep orange pollen that every trace of its nationality is hidden.

Size of the Grains

There is a very great diversity in the size of pollen grains in different groups of plants. In thyme (*Thymus serpyllum*), for instance, the grain is only 20 micra (1μ = about 1/25000 inch) in length, whilst in *Œnothera biennis* (the evening primrose) it runs

up to 220 micra. Taking at random some of the commoner pollen suppliers this variation will be seen at a glance:

Strawberry	25 micra
Figwort	30
Sallows (willows)	30
Charlock	40
Gorse	45
Raspberry	45/50
Tamus communis	50
Plum	50
Apple	50/60
Hawthorn	55
Malva sylvestris	110
Hyacinth	60/65
Tulips	70

Structure and Shape

When viewed "in the dry" under a moderate magnification, a pollen grain is a very different object from one taken, say, from a bee's leg or from a sample of honey; and for purposes of identification it is better examined in the latter state.

The wall, as a rule, is formed of three layers surrounding the protoplasm of the cell, amongst which is frequently found some grains of starch and some globules of oil. In the process of fertilization, the protoplasm is extruded through the walls in the form of "pollen tubes," which lengthen and make their way down the loose cellular structure of the

female pistil to the ovule in the ovary of the flower.

The outer walls of pollen grains exhibit a wonderful system of markings and sculptures, with patterns mostly characteristic of the orders of plants to which they belong. Carefully manipulated under the microscope, these markings resolve themselves into pleats, furrows, thin places, windows, and tiny lids.

In *Mimulus*, the thin region has the form of a spiral; in the passion flower the thin places are ring-like; in *Umbelliferæ*, *Rosaceæ*, *Papilionaceæ*, *Scrophulariaceæ*, and other groups of plants, little circular windows lie hidden in the grooves, the number varying from plant to plant.

If pollen grains are placed in water, the general meaning of this is made clear. For the protoplasm to expand inside the cell, and form those long fertilizing "tubes," a considerable quantity of moisture is needed. The pleats and thin places are admirably formed for this rapid absorption. Fluids readily pass through them, and the grains quickly occupy two or four times their original space. The thicker parts of the coating are saturated with oil and therefore are not affected by the fluids. The pressure set up by the quick absorption thus cause the windows to open or the lids to lift, and out of them the protoplasm is extruded in the form of tubes of a length similar to the pistil of the flower they serve.

The pollen of the *Entomophilous* plants is characterized by various ridges, spines, and teeth

which enable it to cling readily to the coats and hairs of visiting insects and animals for transportation.

That of the *Anemophilous* (wind distributed) group, on the other hand, is classified as dusty pollen with smooth and non-adhesive surfaces which allow it to be blown through the atmosphere in clouds, as one may see demonstrated in any hazel copse in spring.

Colour of Pollen

It is often a matter of interest to the bee-keeper to know what flowers are being worked, and experience will often supply the information from the shades of colour of the balls the bees bring into the hive.

A few of the commoner colours may be mentioned here:

Dandelion and broom	Deep orange
Gooseberry	Dark green
Sycamore	Greenish yellow
Apple	Very pale yellow
Crocus	Orange
Charlock	Pale yellow
White clover (in small loads)	" A sober brown "
Red clover	Dark brown
Sainfoin	Brown
Pear	Crimson
Poppy	Dark purple
Blackberry	Greenish white
Raspberry	Similar to apple
Sallows	Greenish yellow
Gorse	Yellow to dull orange

The Value of Pollen as a Foodstuff

The importance of supplies of fresh pollen in spring is a point with which every bee-keeper is concerned. For success in quickly building up depleted stocks it is an absolute necessity. During the winter months, when brood-rearing is at a standstill, little or no pollen is needed, and colonies will exist to perfection on sugar syrup. But when once brood appears in the hive, there comes the special need for fresh pollen, and fortunate is the bee-man who has within easy distance plenty of gorse and dandelion.

It is evident that the properties of pollen are not so important to mature bees as to the growing and developing brood, and when it is shown that this product of plants is rich in protein, the reason is explained.

Protoplasm—the matter of life—the basis of all organs and tissues of living matter, contains much albuminous or proteid matter, and for this reason protein is an absolute necessity for the growth of all animal bodies, human as well as insect. Man can procure his protein from such substances as milk, casein, vegetable gluten, and the nitrogenous substance of peas, beans, lentils, etc., known as legumin; but, so far as bees in particular are concerned, there has not yet been found anything to take the place of pollen as a supplier of the necessary protein for the development of the larvæ.

In a *Bee World* review of the work of S. Soudek (Czecho-Slovakian) in this line, a considerable number of experiments are detailed, extending

over years; and the only practical result that was obtained is summed up in the last four lines of the review: "For the present time, so long as we have not any security for the effectiveness of other pollen substitutes, I can advise bee-keepers to feed bees in the time of lack of pollen (springtime) with fresh white of egg stirred into sugar syrup."

Pea-meal is more usually recommended as a substitute for fresh pollen in spring in districts where the real thing is not readily available; and Samuel Simmins found that to "mix it into a stiff paste with honey and plaster it in an empty comb, was a good means of introducing it directly into the brood nest."

VI

THE DOMESTIC LIFE OF THE HONEY BEE

In a bee-keeping district one often notices a procession of bees coming out of and returning to a hole in the trunk of a tree or a chink in the wall or roof of a house. On inquiry, it is found that a swarm of bees has taken possession. If unmolested, they will remain in this occupation indefinitely and, apparently, flourish with all the appearance of health and prosperity. Some day, however, the owner of the domicile may desire to be rid of their gratuitous presence. A local expert will be called in to evict them, and most often his reward will be great in the fruits of their accumulated toil, as a paragraph in the district newspaper will duly record (with some exaggerations).

How did the bees arrive there and come to do so well without any attention or help?

The bee has been for so many ages a chattel of man that it has come to be looked on as a domesticated, or, at all events, a semi-domesticated animal. And so inseparable has the skep or architectural hive and its cleverly designed fittings become associated with the bee, that one is very apt to look on it as being entirely dependent on man's fostering care and neighbourhood.

Whatever has been done in this line, however, has been done to suit man's own convenience. The bee would probably rather be without all the exactitude and formality of civilized conventions. It works as strenuously and harmoniously any time in a derelict lard tub as in a "W.B.C." standard hive!

The Swarm

So, when in the natural round of events the emigration instinct arises in a well-to-do colony, housed either in a hollow trunk or in an elaborate hive, and prompted by causes of internal economy to be explained, another homestead is sought, convenience rather than looks appears to influence the choice.

As the swarming season approaches, one may notice odd bees buzzing around and prying busily into chinks in walls, holes in trees, empty hives, a gap in the roof-work of a house. One's attention is drawn to the presence of the insect by its quick, nervous motions; its evident scrutiny of the hole or object from every angle. Finally, when every approach is examined and safety appears certain, one notices its headlong dive into the interior.

In very many instances where this has been observed, a swarm has taken possession a few days later, coming, it may be, from quite a distance. From this circumstantial evidence it is inferred that scouts had been busy previously locating a suitable dwelling. It is somewhat difficult, perhaps, to prove the point satisfactorily, but if one has ever noticed the almost simultaneous flight of an absconding

swarm, and the speed with which it disappears in a given direction, one feels beyond a doubt that it was no haphazard exodus in search of a home. It is all so certainly in accordance with what one has learned to expect from bees.

It is an interesting sight to watch the entry of a swarm into a new dwelling. The first bees to find the opening spread out their legs on the threshold, elevate their bodies, and fan vigorously with their wings. If gifted with a delicate nose, the onlooker may become aware of a certain sweet rose or musky odour arising from the bees, and being wafted backwards by the vibration of the shimmering wings.

As the first ranks move onwards into the opening, the action of the wings and bodies gradually spreads, until in a moment or two the whole collection of bees is fanning strongly and distributing the scent, moving onwards all the while into the opening.

If one gets down and closely examines the bees while this is going on, it will be noticed that the sixth and seventh upper segmental rings of the body are stretched apart so as to expose a white patch in the joining membrane. This is known as "Nassenoff's gland," which was described in 1883 by a physiologist of that name, and again later by F. W. L. Sladen. A very full account of the functions of this organ is included by Mr. Sladen in his valuable little book *Queen Rearing in England*.

Mr. Sladen describes the scent as "pungent, suggesting a mixture of iodine with formic acid";

but to the present writer it appears as described earlier, "a pleasant rose or musky odour." Sladen's description seems more applicable when a jar on the hive causes the bees to lift their tails in alarm and put out the tips of their stings, on which a tiny drop of poison gathers.

The function of "Nassenoff's gland" and the occasions of its use suggest that the scent is emitted as a means of social attraction or flag of truce. It is used in such different (and yet essentially similar) occasions as clustering in the swarm; marching into a new home; at the entrance when a virgin queen is taking her first flight; when a young bee is being compelled to enter the hive of a strange colony; and in many other cases.

On taking up residence for the first time in a hole in a tree or a wall cavity, one of the earliest jobs done is to clear out any loose debris, and to smooth off as well as possible the walls. Afterwards, these are coated with propolis, which renders them water-proof, and suggests a good coat of varnish.

While this is being done, numbers of the younger bees, clinging to one another's legs, will have attached themselves to the roof, from which they hang down in thick festoons while wax is being secreted by special glands on the underside of their bodies. In very young bees, as in very old bees, the wax glands are not at their best. It is (according to Dr. Phillips) just in the stage of life before the young bee enters on its field duties that wax is best produced.

As the oval wax scales (1/10 inch by 1/16

inch) form and harden, they are removed from their "pockets" by spines on the third pair of legs. The scale is then taken up by the first pair of legs and passed on to the mandibles, where it is masticated into a condition suitable for comb building.

Each bee, apparently, produces, kneads, and lays in position on the agreed foundation its quota, and then returns to the cluster. The shaping of the cells is done as the accumulation proceeds. Pellett describes the procedure as: "The work is done very much as though men in building a wall each brought a single brick and put it in place and went away."

The work of building a comb is not necessarily all carried on from one position. It may be started in several places, and as the edge of each approaches the others, they are united in a marvellously efficient way. It is only occasionally one can observe where the joint has come.

It is usually dogmatized from experiments made by Huber, many years ago, that to produce a single pound of wax, the secreting workers need a consumption of 20 lb. of honey. Simmins, however, more recently claimed from actual experiment to have proved this ridiculous. He found that "no more than $6\frac{1}{2}$ lb. of honey is required in the production of a pound of wax"!

With a good queen moving about, impatiently waiting to lay her eggs in the cells, the work of comb building goes on rapidly. The field bees also begin to bring in their nectar and pollen from the

meadows, and thus the competition between egg-laying and storing arouses that vigour which has become proverbial to a newly hived swarm.

The Parent Colony

Leaving our newly housed colony of bees working hard to store their dwelling both with food for winter and with increase of population to stand the incessant wear and tear of life, let us retrace our steps to the causes which produced the swarm.

The colony from which it sprang was doubtless housed in a hive entirely satisfactory from its owner's point of view. Being populous enough to spare a good strong swarm later, it was almost certainly headed by a " last year's queen," fecund and vigorous.

Beginning to lay in the early days of the year, the first eggs would be deposited in cells covered by the winter cluster, and more or less in concentric areas. Working inside the cluster to take advantage of the higher temperature there, the circles would be widened and their area extended. As the earliest laid eggs would develop first, the queen would return to the emptied cells to deposit more eggs. The emerging brood would duly take up the nursery duties, and as the season advanced, so the size of the colony would keep pace with it.

The earliest brood would be, by choice of the queen, workers; but if, by chance, there should be any drone cells included within the cluster, sooner or later she would lay in them, and so males might be produced abnormally long before there was a

likelihood of any use being found for their services —the fertilization of the young queen.

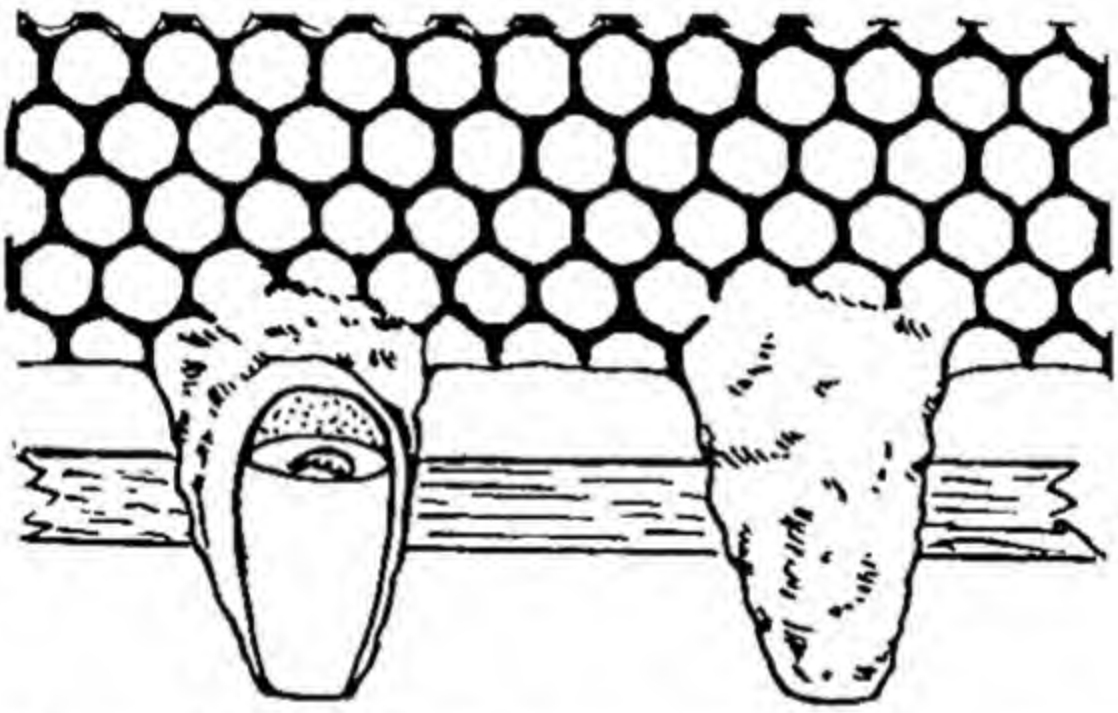
In this connection, it would seem that the workers exercise some, as yet little understood, power of control over the hatching of the eggs. Drone eggs laid in spring, and sometimes worker eggs laid in autumn, are often allowed to remain in the cells undeveloped. Research appears to be needed on this interesting (and important) point.

If the hive was abundantly provisioned when the bees went into winter quarters, and its insulation was efficient to conserve the normal heat of the cluster, by the end of March or early April the colony would be getting fairly strong. The incoming nectar and pollen from the early flowers would continually stimulate the production of eggs, and by the end of April and the beginning of May, the combs would be crowded by young bees.

It has been explained already that for the first fortnight of its life the newly hatched worker, with the exception of short "playtime" flights in the sun about midday, is detailed for the numerous domestic duties of the hive: nursing, comb-building, etc. And when, say, in April and May, other workers are hatching out at the rate of anything up to 2,000 per day, it needs little imagination to visualize the resultant overcrowding: young bees moving slowly about the brood-combs, dipping into each cell and adding to the food of the growing larva; capping over the cell at the appointed time; the field bees struggling about trying to get rid of their loads of pollen and nectar.

Preparations for Swarming

Whatever might be the real incisive cause—overcrowding, lack of ventilation, the call of instinct—this for the moment is immaterial to description—a certain number of specially built queen cells were now prepared. Prompted, no doubt, by her attendants, the queen mother would presently lay a fertilized egg in each. If nothing untoward occurred meanwhile to change the desire of the colony, the eggs would be allowed to hatch, and in



Natural built queen cells (one cut to show section).

three days the feeding of the resultant larva would commence.

For five days the tender organism lived and floated in a sea of opaque white jelly showered on it by the young bees; feeding at every pore, it would seem, and growing as if by magic from the tiny, lettuce-seed-shaped speck to the big dropsical object from which later the slender, dainty princess is to come.

Numerous other cells would doubtless be passing

through the same process simultaneously, not necessarily all on the same comb, and not all at the same stage of growth. As many as a dozen might be started, according to the strain and strength of the colony; some on the sides, some on the bottom, or practically anywhere on the combs.

Whilst this was in progress, a certain growing uneasiness would be spreading through the hive, a general feeling that great things were pending. This would be manifested by " mass-meetings " on the flight board; a tendency in the workers to stay around home, thereby further crowding the hive. The queen's egg-laying would be eased off by reason that the attendant bees plied her less and less with food. Her body would become less distended and she would " go light," thereby improving her powers of flight when the great moment arrived.

At the fifth to sixth day from hatching, the larva would be full fed. The mouth of the cell would be sealed over by the bees with wax, and lined inside the opening end by the larva with silk.

If the appointed day was bright and satisfactory, this normally would be the time for the first swarm to issue, although it might be varied by the sudden advent of bad weather and a little by the strain of bees. Italians are somewhat given to swarming with the cells in an earlier stage of preparation.

The Swarm in Action

Excitement runs high as the first movement in the great drama begins. Just where and how the

business starts is hard to define. Simmins, a very close observer of his bees, appeared to think it began with the old queen, who, after having willingly laid the eggs in the queen cells, afterwards evinced a growing uneasiness, and, perhaps, some jealous anticipation of the part these developments were to play in her own future. She would like to destroy the cells before the inmates became dangerous. Debarred from this by the action of the workers, her excitement produces a like effect on her family and incites them to flight.

That sounds very human—perhaps too much so—but it certainly has the element of truth in it.

To the ordinary observer, what happens seems somewhat more commonplace. The queen does not appear to be in any way concerned more than as one of the rank and file, except possibly at the conclusion of the flight. She mostly comes out of the hive about midway, or towards the end of the rush, looking as if she was the half-hearted victim of a bad example.

As the morning advances, there is a tendency in the field bees to hesitate as they come out. Instead of flying off like a shot, they gather in knots or run hastily in and out of the hive, crawl up the front and take short circling flights from there, uncertainty written in all their movements. Some go to the fields and return with half loads. There is little of the single-mindedness and vigour of an ordinary working day about them.

A subdued humming becomes noticeable in the depths of the hive, and it rises in a gradual

crescendo. There are small rushes to the front of a few bees at a time, and a launch into the air, the crescendo rising. It is as if "playtime" has begun, but instead of it being limited to the "children," the whole population is taking a part.

There may be several false starts and as many returns—excitement meanwhile becoming general.

At last there is a rush, a clittering and a glittering of wings; the joyous hum becoming a dominant note. Massed ranks pour out on the alighting board. In a moment the air is a giddy, whirling ballet of intoxicated gaiety—round and round, up and down, far and near, the sun glancing on the filmy wings.

A few moments of this and at one point there emerges a noticeable slackening of movement, a narrowing of circles. It may be around the high branch of a tree, or a low bush near the ground. The flight of the queen is weakening; her unaccustomed wings are feeling the strain. One chosen twig or sprig is the focal point on which all the vision of this bee world is centred. The crescendo is failing; the bees are clustering. A strange silence is taking the place of the joyous hum.

You may go close up and watch in perfect safety the formation of the cluster, if you choose. With bees as with mankind, "a full paunch makes an easy mind," and where contentment dwells there is no room for enmity.

With an eye on the unknown future, every bee had stored its stomach with provisions for four days.

In that time there would be a vacant house to enter and clean through; there would be combs to build with the wax scales they would distil slowly from their own secretions.

And so, as in the beginning of this chapter, we presently find that, lacking an owner's attention, the swarm has flown away and taken possession of a nook or cranny which to them is henceforth to be "home, sweet home." The summer is half gone; clover is on the wane; and winter looms bleak beyond it all.

Labor omnia vincit. So, vigorously, they set to work, each in its own way, to furnish and provision their dwelling, and, like settlers in a strange country, to lay truly the fortunes of a new colony.

The Parent Colony Again

And how, in the meantime, are things faring in the deserted mother hive?

Where but a short time before all was excitement and bustle with the coming and going of scores of thousands of bees, the hive has now the appearance of a stricken city. A glance through the combs would reveal the existence of perhaps a dozen queen cells in different stages of "ripeness"; a considerable population of young workers who have hatched since the swarm left, or whose flight was not sufficiently advanced for them to go out with the others, and who are now busily tending the uncapped brood. There is also a small regiment of field bees who had been away when the swarm left. These inhabitants, together with the constantly

emerging brood, will in due course restore a certain strength to the hive.

In about eight or nine days from the issue of the swarm, one of the young queens will bite her way out of the cell. If the weather is suitable then, and the hive populous enough to warrant it, a second swarm (or " cast ") will issue with this queen—or " princess," as she is sometimes called, being as yet unfertilized.

Should the weather be unsuitable, the exit of this " cast " may be delayed for a day or two. In the meantime, restraint will be exerted by the bees to prevent the emergence of the other " princesses." These may even have proceeded so far as to cut round the capping of their cell, but, until the will of the hive permits it, they passively await permission to come forth.

In this waiting period there occurs what is known as the " piping " of the " princesses," and, listening by the hive, the peculiar sound may be distinctly heard. It seems to be a fight challenge of one " princess " to another, for, except under certain circumstances, custom forbids a divided authority.

Normally, if the population decides against a " cast," the first " princess " to emerge is allowed to destroy her unborn sisters, which she will do without compunction. She may even be assisted in the killing by the workers.

But if this does not occur, it sometimes happens that when the " cast " issues, it will be accompanied by several " princesses " who have escaped from

their cells in the excitement. In this case, normality will be restored sooner or later by single combat resulting in the "survival of the fittest," one "princess" only being allowed to remain to become head of the colony.

It may happen that a very populous hive, if uncontrolled, will throw off "cast" after "cast," each getting successively less, until it leaves itself so weak that it may barely survive the winter.

In the foregoing it has been sought to outline in a general way a year's events in the working life of a colony uncontrolled by modern skill. On the basis of this, it is proposed to devote the second part of this book to the practical running of an apiary by up-to-date methods, and to show how, by taking advantage of the bee's natural instincts, they may be turned to man's profit.

PART II

HONEYCRAFT IN PRACTICE

I

THE BEE FOR PROFIT AND PLEASURE

For serious and profitable Honeycraft there is only one bee which can be relied on to give really satisfactory results under all conditions—the pure Italian, or its equivalent, the American-Italian strain.

This assertion, bold as it may appear, sums up the accumulated experience of the best known and most extensive bee-men all over the world: U.S.A., Canada, Australia, New Zealand, as well as our own country, in fact wherever bee-keeping is taken seriously enough to be made a profession of.

As a result of ages of selective breeding, the modern Italian is truly a pedigree bee in every sense of the word. It is the real aristocrat of its race. It is gentle and docile, and under the real bee-man's touch, it can be handled without the aid of either smoke, gloves, or veil. When the hive is opened and the combs are lifted out for inspection, the Italian bee remains quietly in its place, and does not rush wildly about and boil over the sides like the black bee does. It is extremely prolific, and, so long as it is supplied in advance with plenty of room, there is little tendency to swarm—a most

important point in modern bee work! It is hardy and winters well. And, perhaps above all, it is an indefatigable worker in every reasonable condition of weather, early and late.

Other strains doubtless have similar virtues—the Carniolan is gentle and industrious, but it swarms excessively even with abundance of room; the Dutch is a good worker, and when pure, easily handled, but it will swarm at a given time even if the hive is " half full of space "; hybrids, after the first cross, have most of the vices and some of the virtues—but, as will be shown later, the pure Italian is the only one in which are developed the whole of the characteristics necessary for pleasure and profit in modern Honeycraft.

For years the naturalized Italian bee has been bred in our own country by such expert queen-rearers as Simmins, Sladen, Barrett, Sturges—to name only a few who have made a reputation by their skill and knowledge; and in Italy, the pure strain has been perfected and preserved by Piana, Penna, and the Tortoras, so that there is every opportunity for the ordinary bee-keeper to introduce the choicest strains into his hives at a price within the reach of all.[1]

The introduction of a fertile foreign queen to an

[1] NOTE.—As this is a severely practical book, no apology is offered for the introduction of names and prices when such is considered beneficial for the ordinary interested reader. Too often he is kept off the pursuit by want of knowledge on these points.

existing colony is a very simple matter, needing only the observance of few and common-sense precautions. The rearer supplies explicit instructions with each queen in simple terms which need no expert explanation, the underlying principles of which will be dealt with fully in a subsequent section.

Success in honey production depends on the constant and intelligent handling and manipulation of the combs at certain times and in different states of the weather. If, as is most often the case with black bees and hybrids, the opening of the hive is a strain on the nerves because of the bad or uncertain temper of the inhabitants, the inevitable result becomes one of neglect. Neglect to know the exact condition of every comb in every hive at stated intervals, especially prior to and during the swarming period, leads to constant turmoil, anxiety, and loss of bees at the most critical time of storage.

For this reason alone—that is, comfort and pleasure in handling and inspection—the Italian bee is a necessity in any apiary, large or small, where Honeycraft is taken seriously.

The vital point of all successful honey production is the avoidance of swarming. When a swarm leaves the hive, it means a dislocation of working conditions at the very height of the honey-flow, and a division of the working force.

Swarming can be prevented by a comparatively simple system of manipulation to which the Italian bee lends itself perfectly.

In these manipulations it is necessary to be able to " spot " the queen instantly; and as the opera-

tion is carried out when the hives are crowded with bees at all stages of development, the distinctive colouring of the Italian queen is of the utmost assistance to this end. After a little experience the eye automatically distinguishes her large, highly coloured body amongst the crowds of her attendants and family. Black queens are not so distinctive in their colouring, and this, together with their constitutional uneasiness and refusal to be crowded, renders the black races more difficult to deal with.

II

THE HIVE

The " Stoney-Archer " Design

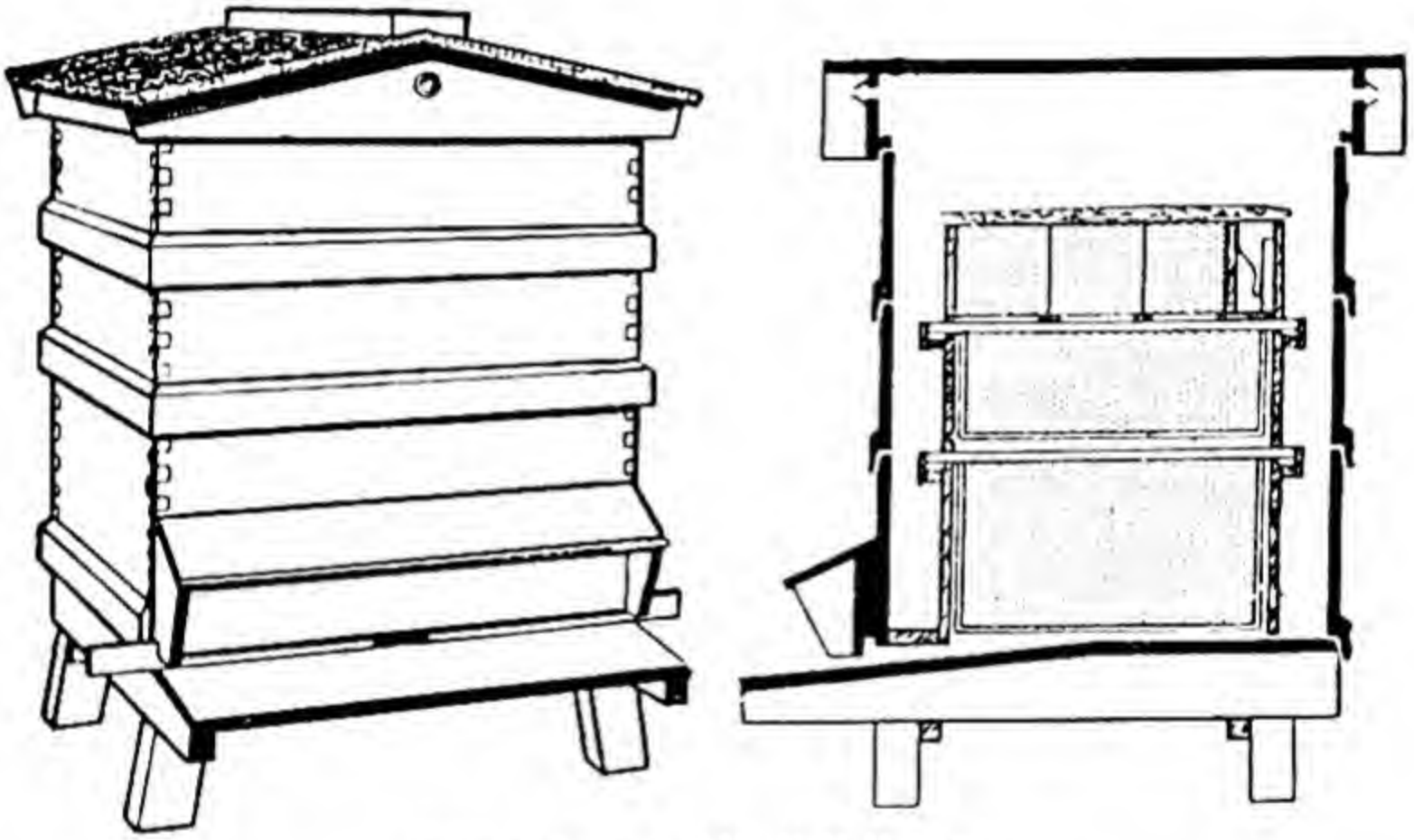
Good bees should be housed in the best of hives if they are expected to give satisfactory results. That goes without saying.

We have discussed the points of what is considered to be the best bee. The hive is the next most important thing.

What are the elements of a good hive?

The introduction of the Italian bee, with its prolificity in egg-laying and its disinclination to swarm until driven to it by its owner's neglect or ill-management, brought a new problem for hive builders. In place of the " Standard W.B.C. " hive complete with brood-chamber containing ten frames, " one shallow super, and one rack of sections " as per advertisement, with all its cumbersome extraneous outer covers and plinths, and nearly as big as a week-end cottage, which yet only accommodated the old unprolific black bee up to a certain point, the demand was for something more portable, cheaper, and capable of being built up to half a dozen brood-chamber stories if needed.

To take advantage of the swarm-prevention manipulations introduced by the great American bee-men, it was necessary to have a hive in which what one day was the bottom brood-chamber, the next day might be lifted to the attic position without inconvenience. Our old single-walled hive would not do it. By reason of the entirely useless porch attachment, the ground floor had to remain so to the



The original "W.B.C." hive.

end of its life. The " W.B.C." *can* be storified—but at what a cost! And what a nuisance to the man with a hundred hives to look after!

In 1926 a design now known as the " Stoney-Archer " hive was introduced to bee-keepers through the pages of the *Scottish Bee-Keeper* by Col. Stoney-Archer; and later, full details of it appeared in the *Bee World*. This hive gives the

maximum of convenience with the very minimum of cost.

On the latter point, Col. Stoney-Archer stated in the *Bee World*:

"Without any previous experience to speak of in carpentry, I made seventeen of these hives in 1923, and the cost for materials worked out at less than 7s. each for the complete hive with two brood-boxes. The details of the cost of every item were published the following year, when I obtained first prize for a 'simple but efficient hive,' the cost of which for materials for twelve was not to exceed £4."

This hive, with some modifications (to be described), has been tried by the present writer carefully, under all weather conditions in the Peak District of Derbyshire and in Sussex, and it is with the utmost confidence it is now described as the "Premier" hive for all purposes. Anyone with the ability to saw straight as well as see straight, and to drive a nail, can make it.

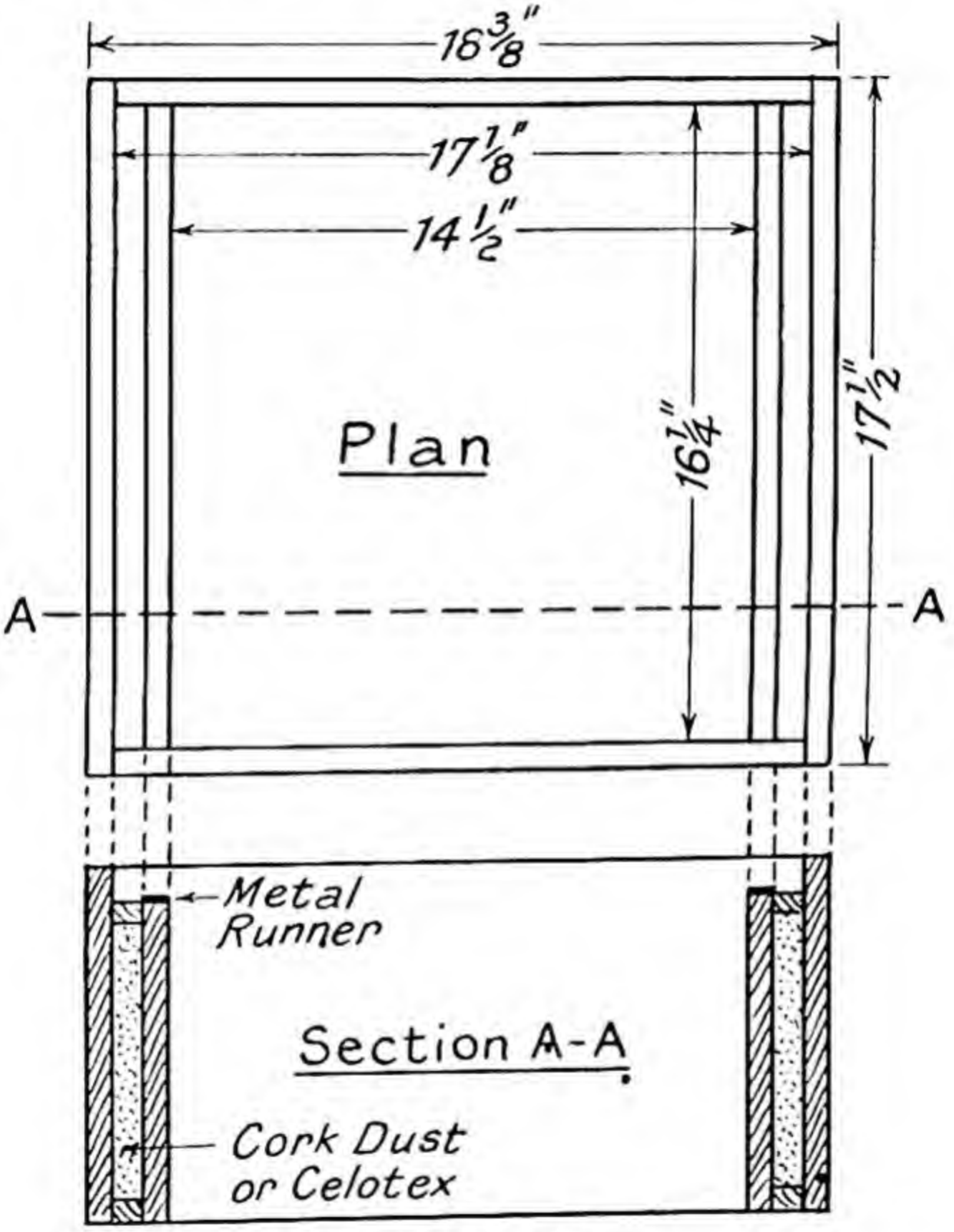
The details of practical Honeycraft to be described are from the standpoint of the use of this hive.

Construction

The *Brood-Chamber* to contain ten British Standard Frames and dummy is made up of the following:

2	pieces of yellow deal (red deal in the North of England)		$17\frac{1}{8}'' \times 8\frac{7}{8}'' \times \frac{5}{8}''$
2	do.	do.	$17\frac{1}{2}'' \times 8\frac{7}{8}'' \times \frac{5}{8}''$
2	do.	do.	$16\frac{1}{4}'' \times 8'' \times \frac{5}{8}''$

That is, 8 feet 6 inches of nominal 9 inches by $\frac{3}{4}$ inch prepared (actually measuring $8\frac{7}{8}$ inches by $\frac{5}{8}$ inch) at, say, 3d. per foot run, is 2s. 2d. It is necessary



Details of brood-box.

that these *net* sizes should be adhered to strictly.

As a preliminary operation the two pieces $16\frac{1}{4}$ inches are to be cut carefully to 8 inches wide,

which, allowing for a saw-cut of $\frac{1}{8}$ inch, will leave two strips $\frac{3}{4}$ inch wide.

The erection is a simple matter now of nailing together at right-angles, or *square*, as a carpenter would put it. If 2-inch "lost head" oval brads are used, the heads can be punched in and filled afterwards with putty to hide the iron.

A skilled woodworker, no doubt, would prefer to dovetail or corner-lock the joints, and in that case, of course, the front and back pieces would need to be $1\frac{1}{4}$ inches longer to allow for this. But in actual use there is no particular advantage in this, the writer has found.

A glance at the accompanying diagram will make the operation of nailing together quite clear.

A slight chamfer taken off the top outer edge of the brood-chambers avoids wet creeping in when in use.

It is merely a rectangular box with the outer walls $8\frac{7}{8}$ inches high, and the two inner walls 8 inches high, nailed together so that the joints of the outer box are held together by the opposite nailing of the inner walls. The $\frac{3}{4}$-inch slips cut off the side walls may be used between the double walls and nailed in place to form a floor to the enclosed spaces, as shown, the tops being filled in with other pieces.

Col. Stoney-Archer apparently did not consider it necessary to fill in the double walls; but the author found it advantageous to do so with either Celotex or granulated cork (such as grapes are packed in at the fruiterer's shop), as an additional insulation to stand the severe Peak District winters.

The relative efficiency in insulation is 35 per cent. for granulated cork as against 15 per cent. dry dead air.

A pair of " metal runners " (at 6d. per pair) are now fixed in place with gimp pins on the top of the two inner walls, and the brood body is complete.

When the standard combs are put in, it will be found that $\frac{1}{4}$ inch bee-space is allowed for above and on each end of the frames, which is in accordance with general usage and practical convenience. Some makers prefer to have the bee-space below the frames, but it is a matter of taste mostly, perhaps. As the author's floorboard is made, he finds it works best with the space above, as shown.

The combs hang parallel with the entrance, which makes the brood nest practically draughtproof, as well as giving the bee-man the convenience of working from the back of the hive. Other benefits of this will appear as the description proceeds.

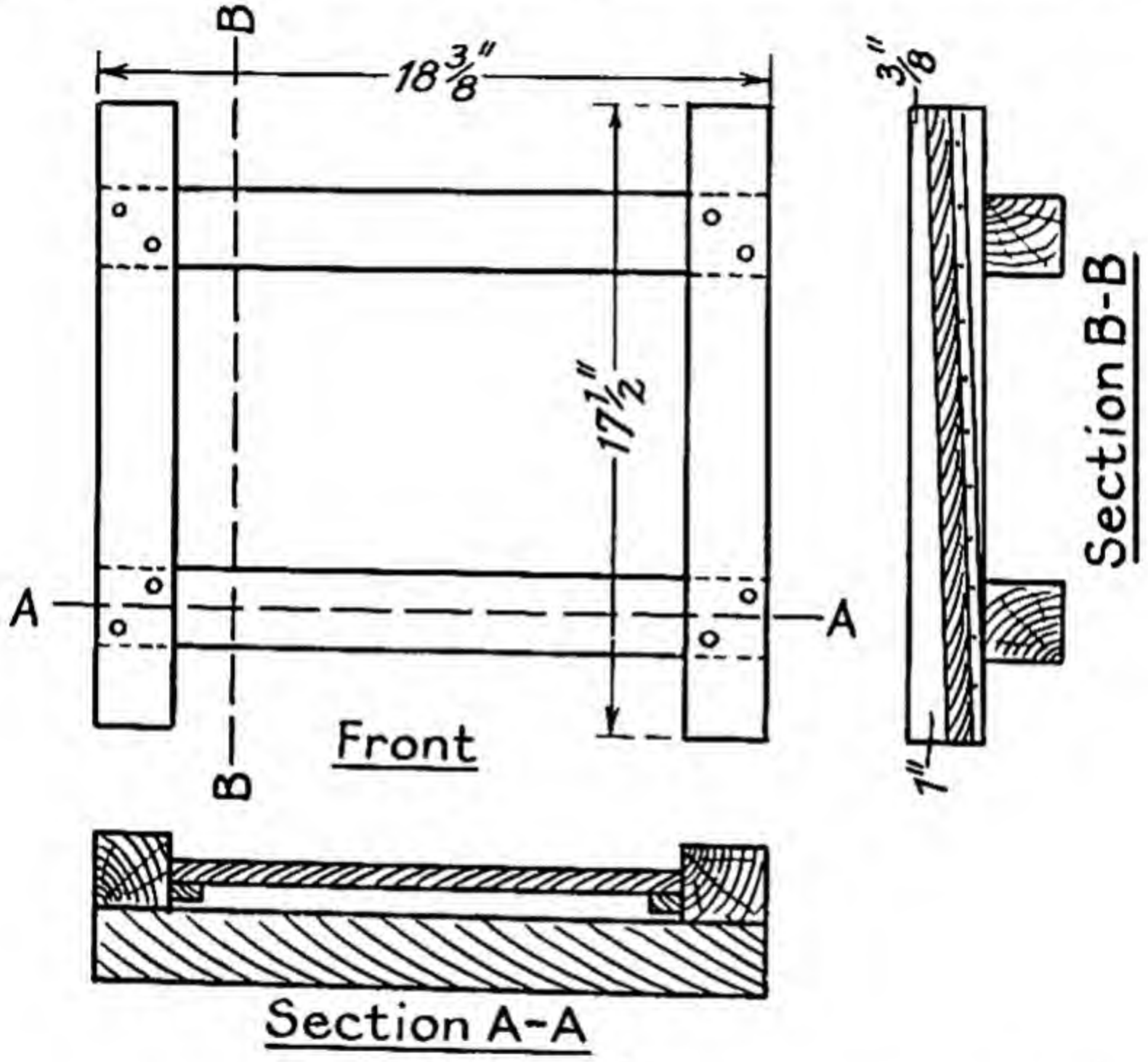
In a good district it will be found that a prosperous colony, headed by a first-class Italian queen, will require the use of three standard bodies for the production of extracted honey, and the hive should therefore be provided for to this extent.

The Stand next claims attention (see diagram), and here the one described differs considerably from the original.

The requirements are:

2 pieces of deal $17\frac{1}{2}'' \times 2'' \times 2''$ finish
2 pieces of deal $18\frac{3}{8}'' \times 2'' \times 2''$ finish
2 fillets and nails
$14\frac{1}{2}'' \times 17\frac{1}{2}'' \times \frac{5}{8}''$ finish prepared deal

These are stoutly spiked together to form the platform for the floorboard and the rim on which the body-box stands. This is afterwards filled in between the 2 inches by 2 inches with a $\frac{5}{8}$-inch prepared deal floor sloping from back to front, so



The stand.

as to leave a 1-inch entrance at front and a $\frac{3}{8}$-inch space at back.

If one was skilled in the use of tools, it would be preferable to groove the sides of the 2 inches by 2 inches and house the floorboard into them; but as the writer is more rough and ready in his

methods, he found it easier to nail a sloping fillet on the inner faces of the 2 inches by 2 inches and afterwards sprig the $\frac{5}{8}$-inch floor down to it, the grain of the wood parallel with the entrance to avoid the troubles of shrinkage.

The essence of the arrangement is that the 2 inches by 2 inches forms a rigid horizontal framework, and the floor, sloping from back to front, allows moisture to drain away, and also gives a 1-inch-deep entrance at front and a $\frac{3}{8}$-inch at back. In summer, the advantage of this is particularly manifest, as it supplies the enormous population of bees ample passage-room in and out with the maximum of ventilation and the minimum cause for any tendency to prepare for swarming.

In winter, the back entrance is stopped by a plain piece of wood, whilst the front entrance is filled by a similar piece of the right depth, having a $\frac{3}{8}$-inch by 4-inch hole cut in it. (See Plate facing p. 85.)

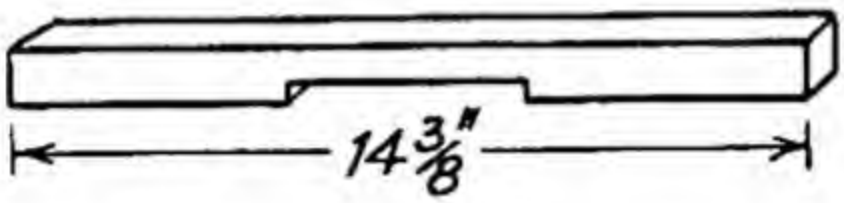
The Deep Roof or Cover is the distinctive feature of the " Stoney-Archer " hive, on which its value for successful wintering chiefly depends. (See Plate facing p. 85.)

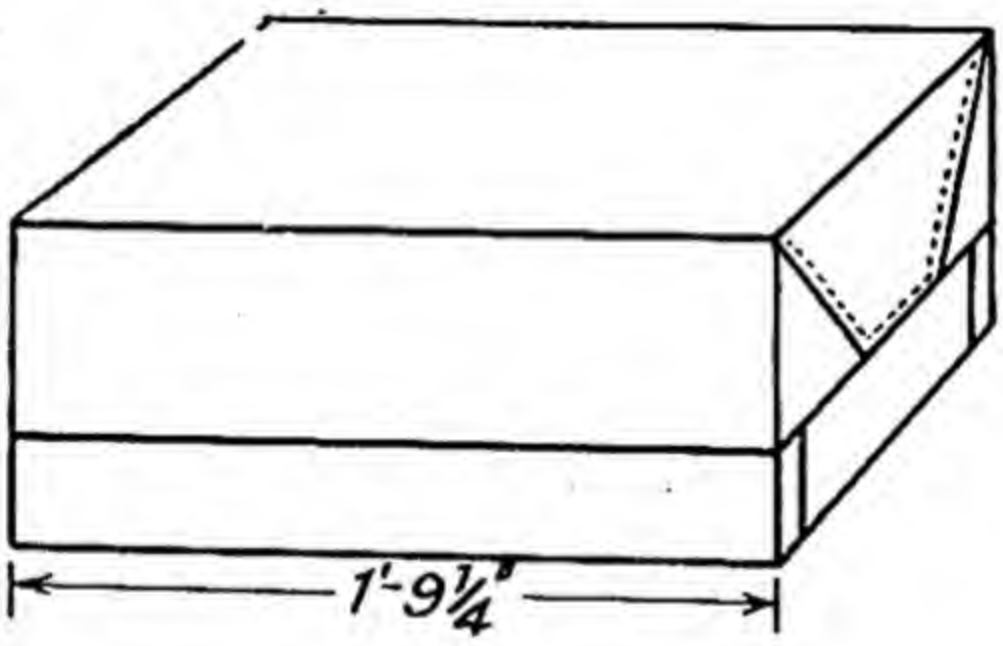
It is formed of 9-inch by $\frac{3}{4}$-inch prepared deal, and is to be large enough to allow a $\frac{3}{4}$-inch (or even 1-inch) space all round when placed over the brood-box. It requires:

2 pieces $21\frac{1}{4}'' \times 9'' \times \frac{3}{4}''$ ($8\frac{7}{8}'' \times \frac{5}{8}''$ finish) for front and back;
2 pieces $19'' \times 9'' \times \frac{3}{4}''$ ($8\frac{7}{8}'' \times \frac{5}{8}''$ finish) for sides.
The top may be of $\frac{3}{4}''$ rough board.

The front and back are nailed on the ends of the side pieces.

The ideal covering for the roof is most probably thin sheet zinc, with the joints soldered; but the author has always found "Pluvex" or "Ruberoid" quite satisfactory when stuck to the wood with the special mastic which is supplied for





that purpose, the edges being afterwards close tacked with tin tacks brushed over with the mastic on completion to keep rust off. One yard of "Pluvex" does a roof nicely (about 8d.), and comes down about two-thirds of the way all round.

The hive is now ready for a couple of coats of creasote, inside and out; or one of the many wood

preservatives—Solignum, Silvertown, Jodelite, or other. And Col. Stoney-Archer recommends two coats of boiled linseed oil outside when the creasote is dry. If the latter is put on hot, it has great penetrating power, and will render the wood rot-proof and practically everlasting.

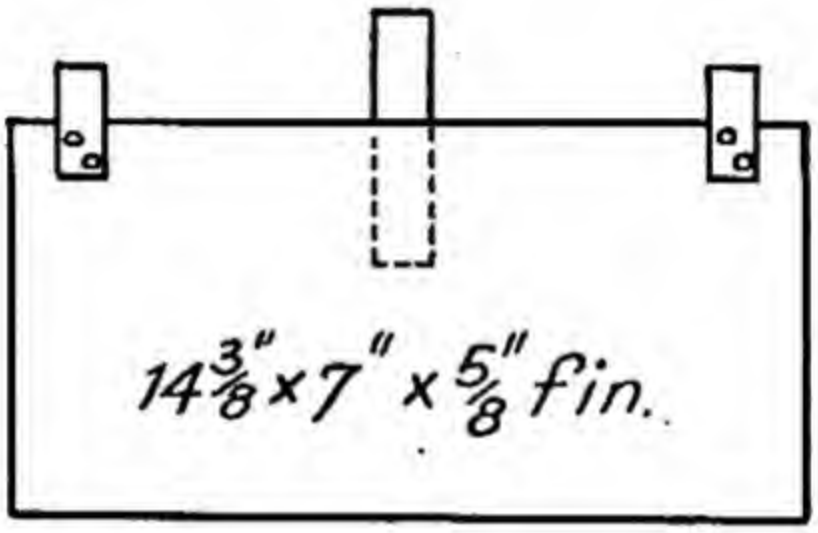
The Top Quilt to cover over the frames (as used by the author) is made from thin box boards (Tate's sugar-boxes or similar) nailed on a flat rim made from $\frac{1}{4}$-inch plasterer's laths, and having a 3-inch round feed-hole cut in the centre. This, normally, is covered with a sheet of glass. In spring, it can be slipped aside if it is desired to feed a cake of candy or to use a bottle feeder.

For winter packing, Col. Stoney-Archer recommends a few newspapers and a sheet or two of roofing-felt laid over the quilt and under the deep roof as insulation against cold and to prevent the dispersal of the heat of the cluster.

The $\frac{1}{2}$-inch space provided over the frames ($\frac{1}{4}$ inch the thickness of the lath and $\frac{1}{4}$ inch the normal bee-space) allows the fullest freedom for the bees to cluster or move in the warmest part of the hive, and thus supplies what is lacking in the ordinary calico quilt which lies flat on the top of the frames and restricts movement.

For the front *Flight Board* (and for the back when used as a supplementary exit in the height of the honey-flow) the author uses a device similar to that known as the "Glassel" extension alighting board (sold by Messrs. Steele & Brodie). This is simply a piece of $\frac{5}{8}$-inch board the length of the hive

front, by any convenient width. Nailed on the edge are two pieces of hoop-iron to fit about an inch over the floorboard, and in the centre underneath a lath about 1 inch by ½ inch thick, with an overhang about 3 inches to fit under the floorboard (see Plate). When this is pushed up close on the floorboard, it is fixed automatically by it own weight, and yet can be removed in an instant.



The Winter " Petticoat "

When packing the bees away for the winter, whether on one or two brood-boxes, a length of roofing-felt (" Pluvex " does nicely) is stretched completely round the hive and fastened with wire or drawing-pins as a further defence against the weather. If rolled up carefully on removal, it will last for years.

This, with the complete protection afforded by the deep roof, and the ¾-inch dead air space all round, makes the hive almost impervious to changes of atmosphere and damp. The bees winter perfectly, and consequently use the minimum of food to keep them in health and prosperity.

The success of this hive since its introduction has been such that it is now made, catalogued, and imitated by most dealers, with more or less adherence to the original instructions of Col. Stoney-Archer. Individual taste in this, as in most things, finds expression in different methods as the result of experience.

Hive Furniture and Equipment

Leaving the hive to dry, and thoroughly exposing it for a few days to the sun and air to get rid of the creasote fumes, attention can meanwhile be given to the inside fitments.

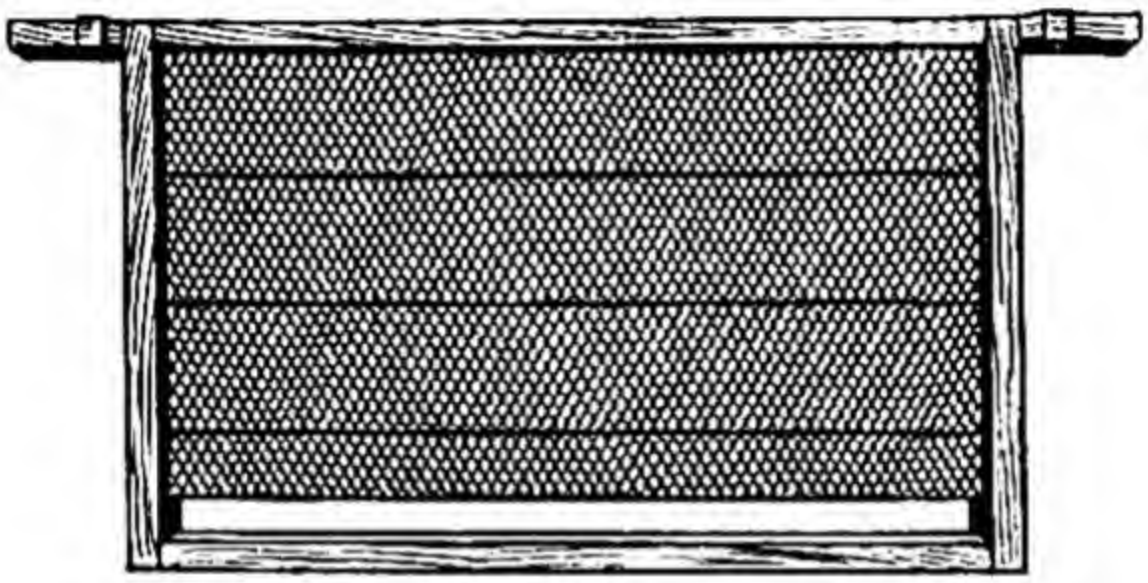
Brood-combs

Modern frames are so beautifully and exactly machined that there is little trouble in fitting them together. After the joints are " driven right home," a fine nail should be put in each to obviate any chance of them pulling apart when in use.

When using the ordinary foundation (eight sheets to the pound), choice may be made of two styles of top bar—the split or the wedge—between which, in use, there is little to choose. The wedge is possibly easier to fit the foundation to, but the split, when completed, feels somehow safer. Usually, one side of the various members is smoother than the other, and in putting together it is to be remembered that the rough side is to be the inside of the completed frame. This point will ensure that the longer slit (which differs in the length showing through the two sides) will come inwards to take the full length of the foundation.

As our " Stoney-Archer " hive is designed for the use of the British Standard Frame throughout—for brood-rearing as well as for storage—and as various manipulations to be described for the avoidance of swarming require that the combs shall be interchangeable, it is necessary that each should be reinforced with wire. By this means, there is no risk of the comb falling from the frame in hot weather or when being passed through the extractor.

In this, as in most other things, there is fashion,



Brood-comb foundation wired.

use, or personal taste. The principal idea, perhaps, is to ensure a straight, well-built comb; but, as mentioned above, the wiring also prevents accidents in the extractor and when manipulating; also, when effectively done, it prevents the sagging of the foundation which results in a stretching of the cell pattern and the drawing out of drone instead of worker comb.

Some prefer to drive fine wire nails through the sides of the frame, and, after hooking the points inside with a pair of pliers, affix the wire to them.

Others (probably the majority) bore the holes with a bradawl or fine pricker through each side, taking care to keep them in the exact centre, and then thread the wire through them, wrapping each end around a gimp pin and driving it in flush on the face of the side piece.

Special soft tinned wire is used for this purpose, and sold by all dealers. The wire should first be well stretched so as to avoid this happening later. This can be done by driving a yard or so off the reel each time without "kinking" it; putting the middle of it under the instep of the foot, and pulling "just so hard" with both hands. Another way is to thread the wire through the holes in the frame, fasten one end around a gimp pin and drive in flush. Now, pushing one side of the frame hard against the edge of the work-bench to make it bend inwards, draw the other end of the wire up taut, twist it round a half-driven pin and drive home. Now, when pressure is taken off and the side straightens, the wire will ring like a tight fiddle string, having stretched to the extent of the bend in the side.

Bulletin No. 128 of the New Zealand Dept. of Agriculture (page 8) shows a neat device to accomplish the same purpose. A couple of stops are fixed on the work-bench at just such a distance that the frame is bent inwards when forced between them. The wiring is done as described above and the gimp pins driven home. When the frame is pulled out of the stops and the sides straighten, the wires are as taut as could be desired.

For fitting in the wax foundation, a board cut to the inside size of the frame is required (13½ inches bare by 7⅞ inches).

The first operation is to get the edge of the wax sheet inside the slit in the top bar. A neat dodge described some years ago in the *Bee Journal* by Mr. W. Herrod, makes the job easy.

"Drive a couple of nails into the bench about ¾ inch apart," he said; "these are inserted in the saw-cut of the top bar. When the frame is twisted half round on them, the cut is opened and held there automatically."

The heads of the nails should be filed off (it may be added) so that they go into the slit easily, and they should stand up about ⅜ inch out of the wood.

The two top corners of the wax sheet should be cut off, say, ⅜ inch, and the sheet will then drop easily into the slit. See that it is in squarely, then twist the frame back to its first position and the top bar closes on the wax. A couple of ¾-inch oval brads driven through the top bar locks the grip, and the next job is to embed the wires completely in the wax. If they are left bare at any point, the bees will often cut the wax away and fill the hole with drone comb.

Wiring and Fixing Foundation

Formerly, and to a great extent even yet, this was done with a toothed grooved wheel known as a "Woiblet spur embedder." Truth to tell, it made a poor job—a botch of a job often!—especially in unpractised hands. If the wheel got too hot, it

would leave a hole in the wax; while if it was cold, it either did not enter the wax or left a pathway along it wide enough for a row of drone cells to be worked.

Science has provided a complete, easy, and perfect substitute in the electric embedder which can be bought of the dealers *or made by a novice at half the cost of a spur wheel.* (See plate facing this page.)

The Electric Embedder—Construction

A piece of wood 15 inches long by 1 inch by $\frac{3}{4}$ inch, three $1\frac{1}{2}$-inch or 2-inch round wire nails (or copper or zinc slate nails for preference), and a yard of flex wire are the bare essentials.

Bore three holes through the 1-inch way of the wood, $13\frac{1}{4}$ inches exactly between the two end ones, and the middle one in the centre so that the three will line perfectly. Wrap the ends of the bare copper wire tightly under the heads of the two end nails, the positive on one, the negative on the other, and then drive in the nails with the heads flush.

With a fine three-cornered saw-file slightly groove the points of the three nails to fit on your frame wire. See that they will come down plumb on a straight wire, or bend slightly to adjust for this.

Now if you fit the other end of your wires to a 4-volt L.T. wireless accumulator, you will find that, when you press your nail points on the wire in your frames, there is sufficient heat put through to embed the length of wire beautifully into your wax.

If a bellpush is fitted in one of the wires to control the circuit, the embedder can keep the wire in place until the wax cools around it and cements it out of sight.

There is no trouble, and, after a little experience, the job is done out of all comparison with that of the old spur embedder.

After the wax sheet has been fitted in the top bar as described, the frame is laid on the board (the surface of which should be damped to prevent the wax sticking) wires upward. The points of the embedder nails are pressed on one of the crossing wires, the switch is pushed, and in a second the wire is sunk in the wax. The current is turned off by releasing the push, and in a couple of seconds more the wax has hardened around the wire. Each wire is treated similarly and the job is done neatly, cheaply, and efficiently.

Dadant's Foundation

Dadant's vertically wired foundation does away with the operation described; but as it really needs specially split frames, it may not appeal to the owner of a lot of the older style combs. It can be used, however, in the latter frames with a bit of manœuvring if one cares to go to the trouble of putting a saw-cut through the bottom bar. The idea of the ready wired foundation is certainly good, and goes a long way to minimize the production of drone cells when and where they are not required. The completed combs, too, are exceedingly rigid and nice to handle.

Spacers

The fitting of metal spacers completes the make-up of the comb. In this, simple as it may seem, there is a right and a wrong way, and it is not always quite apparent to a beginner which is which.

The idea is for the sharp edges of the tin to be towards the inner side of the frame. Sometimes the spacers are inclined to be rather tight on the top bar. In that case time and effort (and sore or cut fingers) may be saved by boring an inch hole in a block of wood, standing the spacer over it, and pushing the top bar downwards through it. If the inner tongues have got bent, as they often do, they must be bent away from the slot before trying to push on the bar.

Ordinary brood-comb spacers are made 1½ inches wide, giving in effect that distance between the *centres* of the combs which, in a natural state, the bees apparently work to. In order to make sure that only worker cells are drawn out, it is a custom with some bee-men to slip back each alternate spacer, which has the effect of bringing the frames closer together. Apparently the comb-builders appreciate the fact that the proximity will not allow them later to form the domed drone cappings, and they, therefore, stick to the original worker design of five cells to the inch instead of four.

III

HANDLING BEES

THE hive and its furniture all ready for the occupants, obviously the next stage of bee ownership will entail a closer acquaintance between the two parties.

Because, on occasion, a bee will use its sting in defence of its home or its liberties, the uninitiated person has a feeling that the only way to avoid stings is to leave the insect severely alone. If by any chance he sees an expert with bare hands and unprotected face calmly lifting out and examining at close quarters combs covered with teeming thousands of bees without receiving injury, he sets this fancied immunity down as a mystery or, in fact, to anything rather than the real natural reason!

The nervous organization of a bee is very highly strung, and, like the wires of a grand piano, it responds to the slightest jar. The shape and make-up of a bee's compound eye acts in the same way on a sudden or abrupt movement. A microscopist will demonstrate this by dissecting, cleaning out, and mounting the cornea so that it may be seen through. As each compound eye is composed of 3,000 to 5,000 facets, set at different angles, the

passage of a rapidly moving object across them sets up a visual commotion multiplied out of all proportion to its cause.

With the disturbing factors of nerves and optics combined, one may easily deduce that success in the handling of bees can only be obtained by the cultivation of a *calm and deliberate gentleness.* This will only come by practice, it is no spontaneous gift. *Caution and confidence* are the bee-man's necessities.

The worst bee will respond to the iron hand in the velvet glove controlled by an observing eye and an understanding mind.

When to Handle Bees

From what we have already seen of the bee's habits, it will be remembered that the older bees go out to field work, and the younger remain in the hive. With this in mind, it becomes apparent that if a populous hive is opened at noon on a bright sunny day, we may expect to find therein these conditions.

With young bees, liberties may be safely taken. It is the old, soured, toil-worn virgin who is a stickler for the proprieties. And in that fact alone lies the philosophy of handling bees.

Weather has a great influence on the behaviour of bees. When thunder is about, the hive is better left alone. Apart from other things, cold wet weather is not a time for opening a hive, as the presence of the old bees in overwhelming numbers is not a comfort either to expert or novice.

Of course, with an extensive apiary it is not possible always to choose perfect weather for manipulations, and then experience alone has to guide the operator in his work. Apart from personal comfort, however, for the well-being of the colony it is better to avoid unsuitable weather conditions for opening the hive. A chilly wind may do considerable damage to a young brood, and an upset may also prevent the gathering of considerable nectar.

The Use of the Smoker

Ages ago it was known that, if by any means a colony of bees could be thoroughly alarmed, its dominant impulse would be to rush to the nearest open cells and fill up its stomach. The domestic arrangements of the home would be upset. The guards would forsake their duty, and the combative instinct would be over-ridden.

From this fact, some bright genius formulated the use of smoke as the alarmer, and the smoker followed.

In the American system of " shook swarming," a similar result is obtained by vigorously drumming and pounding on the outside of the hive to alarm the occupants.

The smoker, as made to-day, is an ingenious arrangement of bellows and fire-box whereby a harmless column of smoke can be set up and directed as desired.

There are two forms in general use: the English upright pattern, and the American. Each has its

good points, but from a view of handiness and general utility, probably the latter is the more desirable. It is a little dearer, but, as the combustion chamber is adaptable to any fuel, and its shape prevents ashes being blown into the hive, it is probably better in the long run for regular use. The hook fixed on the back of the bellows is an exceedingly useful gadget, as the smoker can be hung thereby to the side of the hive close to the hands and instantly available.

Just sufficient smoke—and no more—is to be used. If demoralization goes too far, the opposite effect is gained from what is desired. Experience, however, is the final guide to this.

A good smoker is a necessity, and careful observation of its effects in use on different strains of bees and under varying circumstances is an education well worth acquiring by the serious bee-man.

Fuel for the Smoker

Very handy and cheap cartridges can be made by rolling up a strip of the corrugated packing now in such common use. Roll it up fairly tightly; tie a length of wire round it, or stick a nail through it to keep it from unrolling. Light one end at the gas-ring or the fire, and put it in the smoker, fire downwards; close the lid, and a gentle use of the bellows gives the means to subdue the best or the worst tempered stock.

Old carpet, jute sacking, pine shavings are variously recommended; but whatever is used, the

desideratum is a thick column of pungent smoke without a scorching heat.

The Hive Tool

This, in one form or another, is a necessity for almost constant use.

In order to stop draughts, or from an idea that a crack in the hive is a potential source of danger (as it is if it gets big enough to allow ingress to marauders!), every interstice in the woodwork is filled in with propolis if it is at all possible. This substance, the shiny resinous stuff that varnishes the buds of the horse chestnut tree in spring, and exudes from different trees at other seasons of the year, is collected chiefly at a time when there is no extensive honey-flow on. It has a fragrant smell like resin, and when hard set, it is brittle and can only be broken by force.

For this reason, some kind of chisel-edged lever is required when a hive is to be opened.

The dealers' catalogues give a selection of these in various shapes, but the one the author has found best for all-round use is a broad cutting chisel with a strap to hang it from a button. In this, however, as in other things, personal taste means profit for the dealer.

Veils and Gloves

To the beginner, these usually appear the most important item on the requisition list. Looking at a bee through a veil alters its whole complexion.

The expert, no less than the novice, very often

finds it a comfort to have a veil on his hat, even if he does not pull it down *in public*.

Probably the simplest and handiest form of veil is made from a yard of *black* cotton net. The ends are seamed together, and the top and bottom edges of the resultant tube have a 1-inch hem to hold elastic. The top elastic is made tight enough to grip the crown of a hat, and the bottom wide enough to come well down the neck at the back, while a loop at the centre of the front is fastened by a safety-pin to the top of the trousers. When not in use, the top is released from the hat and falls in a collar around the neck. When needed, it can be lifted instantly over the hat brim. The stretched bottom elastic makes a bee-proof joint all round and keeps the veil clear of the face.

Gloves are an abomination! If, however, the nerves of the novice must have their moral support, probably a pair of old cloth-lined leather ones will supply the temporary modicum of comfort as well as any other. But half the fingers should be cut off. Trying to grasp the ends of the frames with clumsy gloves is an insult to any self-respecting bee, and is certain to provoke ill-temper and consequent discomfort. If a bee cannot reach flesh, every sting put into one's coat or trousers leaves a trace of poison which is worse than a red flag to a bull, and the " Anthem of Hate," sung by a thousand angry (if impotent) attackers, is sure to get on one's nerves and make one do something not on the syllabus.

In any case, the really interested operator will soon dispense with gloves—especially if, by acquir-

ing the right touch at an early stage, confidence is gained by the consequent good behaviour of the bees.

There are some people, however, who never do acquire the knack of correct manipulation, being temperamentally unable to do things smoothly and deliberately, however great their interest may be in the subject. An alleged expert may sometimes so upset an apiary by slap-dash handling that life isn't worth living round the hives for hours after.

Learning bee-keeping with the gloves off may be painful for a day or two, but it is effective—and well worth while.

Let it be recommended here before leaving the subject, that whenever stings are taken in either gloves or flesh, it is wise to give a puff or two of smoke over the part stung. The scent of free poison irritates all the other bees and will turn an otherwise peaceful hive into a hotbed of temper in no time. This applies in the same way if (as often happens) a bee or two are crushed in moving frames or supers. Smoke hides the cause and keeps the peace.

Stings

Normally, a very few stings will render the average person immune to all but the first momentary twinge as the weapon touches the surface nerve-ending—far less noticeable in reality than a similar prick from a needle which may occur any time one sews a button on one's garment. A tiny white circle with a red centre is all that shows for a few moments after one has scraped away the

sting with the lip of the smoker or the sharp edge of the hive tool. There is no extensive swelling or inconvenience felt.

The blood has become inoculated, we say, meaning that our glands have manufactured and distributed a natural anti-toxin throughout our veins which promptly neutralizes the injected poison of the bee. Just as the doctor inoculates a diphtheric patient with the natural anti-toxin cultivated in the blood of an artificially diphtheria-infected young horse. The result is the same.

For the novice, however, a touch of ·880 ammonia kills the pain promptly, and the swelling subsides usually in a few hours.

Opening an Established Hive

With the " Stoney-Archer " hive and a wood quilt, this is a very simple matter. With the smoker well a-glow, give two or three good strong puffs right inside the entrance. Remove the roof. Slip aside the piece of glass covering the feed-hole in the wood quilt, and puff once or twice over the frame tops.

In a moment or two the bees will be " roaring," and if there are any open cells of honey, each will have a customer busily loading up its stomach in great haste.

Now is the time for operations to commence.

If, as is most certain, the wood cover is propolized down, slip a chisel or hive tool into the joint with the hive and gently lever it off, running the edge all round if necessary. Lift the quilt away and lean it

up against the side of the hive so as not to crush the bees clinging to the underside of it.

Have a cloth or two kept separately for this job and spread one over the frame tops, leaving only the ones bare that it is desired to handle. Take out the dummy board from the back and stand it up against the hive ready to replace later. There is now room for moving the combs about without crushing the bees.

As a precaution for windy weather, it is a good plan to sew a button of sheet lead on each corner of the cloth.

If a thorough comb by comb examination is desired, use two cloths—one over the examined combs, the other over the remainder—and as each comb is replaced, draw one cloth over it and roll the other back from the next. This keeps the hive warm and the bees quiet, and avoids them flying about one's face and hands.

The handiness of the American (Root) smoker is apparent here, for it can be kept hung on the hive side by its back hook, right at one's finger-ends. It can also be gripped between the knees, with its nozzle directed over the combs, and a touch of the fingers delivers a puff of smoke just where it is wanted in case of restiveness.

As the examination proceeds, use the hive tool to scrape off any brace comb or superfluous wax that has been put on the top bar, and drop it into a tin or jar kept there for the purpose. This makes the next handling easier, and helps to make the Solar wax-extractor profitable.

Concentrate on the job in hand and train the mind to register what the eyes see. Note what food there is in the combs, the amount of brood, the condition of the combs, and always make a point of seeing " Her Majesty " in person. With use, it is surprising how quickly one's eyes will " spot her "—which is an important acquisition when manipulating for swarm control.

One important point should invariably be observed. As opening a hive causes more or less upset in the domestic arrangements of the colony, it should only be done for a very definite reason. It should be carried out as quickly as possible consistent with proper handling; with a minimum of smoke; and the hive closed down again with deliberate carefulness.

Clearing the Combs

If it is necessary to clear a comb of bees, there are several ways of doing this.

The quickest and least " messy " way, possibly, is to push away all the other combs so as to leave a good space in the hive. Then, holding the ends of the half-lifted-out frame, and keeping a tight grip of it, bring the fists down with a bump on the sides of the hive. This shock will throw all the bees from it into the bottom, too startled to retaliate.

Another way is to hold the comb either over the alighting board or the bared body box, gripping one corner of the frame tightly with one hand, and then give that wrist a smart jar with the other fist.

That, again, will clear the comb; but if there is

much fresh gathered nectar in it, there is always a chance of splashing it over the hive front with the possibility of starting robbing. If that should happen, throw a thin sprinkling of garden soil over the liquid to absorb it, and afterwards sweep it off when its mission is accomplished.

The gentlest way, and probably most usual, is to use a special long-handled "bee brush." One dealer's list says: "When using, lay the brush flat-ways." The author, when using one, finds it better for his purpose to hold the points of the bristles on the comb and then, with a twist of the wrist, "spring" the bees off downwards by successive movements. But *chacun à son goût*—everyone to his taste.

IV

STOCKING THE HIVE

If expense is not the first item to be considered, probably the beginner would find most solid satisfaction in the purchase of a colony already established on, say, seven combs, with a dealer's warranty that it is headed by a "young and prolific queen." That it would be free from disease, of course, *should* be included in the conditions of any reputable dealer.

The current list of a well-known Sussex firm prices a seven-comb stock of English bees at 60s., for May delivery; Italians at 77s. 6d. Later months, for obvious reasons, reduce the value.

May natural swarms are offered in the same list at 35s. to 40s.

Of late years there has been developed a system of what is known as "package bees," imported direct from France in boxes which one of the well-known dealers describes as "a most satisfactory method of re-stocking and a gilt-edged investment," at 37s. 6d.

Those prices will doubtless appear high to those

who have heard bee-keeping contemptuously described as a "cottager's side-line." It may be mentioned, though, that from one hive headed by a prolific queen, and with proper handling guided by knowledge, increase may be made to almost any extent within reason.

Pellett records an experiment carried out by the famous American bee-man, Dr. Miller, whereby in one season nine colonies were increased to fifty-six, all headed by young queens, and no stock unduly weak except one nucleus!

What other branch of rustic industry can offer such possibilities?

There is, of course, one more way of stocking which has begun the career of innumerable bee-men (the world-famous firm of Root amongst them, it is said), which is easy enough in any district inhabited by careless or ignorant bee-keepers. That is the hiving of an absconding swarm which has settled in some convenient hedge or tree. It will, of course, be headed by an old (second or third year) queen; but once established, it may be re-queened readily with an imported Italian queen, or induced (by methods to be described) to rear its own.

Transferring the New Colony on Combs

If the stock has been bought on combs, it will no doubt arrive in a specially designed travelling box with plenty of ventilation. It will have an easily detachable lid, screwed or fastened with spring clips, and in that case there is little to do

except to keep the case in a cool shaded place until late afternoon or evening, and then transfer them comb by comb to the hive.

The combs will have been chosen for their toughness to withstand the bangs and vicissitudes of railway or other mode of travel, and the food in them will, no doubt, be mostly sealed for the same reason.

Because bees, being frugal little beasties, are very averse from breaking open their food stores except under necessity, and, as we have seen, they are never so good-tempered as when they have sweets in their stomachs, it is well to give them some very thin sugar syrup—warm sweetened water is sufficient for the purpose—a short time before the operation. It can be given in a feeder—a screw cap bottle with a few holes pricked in is as good as anything—stood on the perforated panel; or thin syrup can be poured direct through the panel along the comb tops. They will clean it all up, however messy it looks at first.

If it is a swarm or "package bees," it requires perhaps a bit more nerve in the novice to get them in. But here again an offering of sweet liquor will rob the operation of its sting.

If in a Skep

If the bees are in a skep with a covering of canvas, stand the skep, canvas upwards, in a cool dark place to await evening. In the middle of the afternoon fill a jam bottle with thin warm syrup, and tie over its mouth a couple of thicknesses of cheese-cloth. Invert this over the canvas of the skep, and the

syrup will in time percolate through to the bees sufficiently to allow them to fill their stomachs and sweeten their tempers.

An hour before it is intended to liberate them, hang the skep the right way up and the inmates will leave the canvas and cluster in the dome. Be careful not to stand the canvas flat on the ground, or the bees may be suffocated.

In the meantime, make your hive ready for the " march-in " by the provision of a good wide board inclined from the ground to the alighting board. Cover this with a white cloth laid smoothly so as to offer no obstacle to an orderly advance. It is always advisable to inspect your queen as she goes in; the white cloth facilitates this.

When all is ready for the " throw-out," remove the canvas as gently as possible and invert the skep, mouth upwards. Give it a sudden bump on the ground, which will cause the bees to lose their foothold and will heap them in a surprised mass in the top of the skep. Now with a circular twist of the skep shoot them out on the cloth-covered board as near the hive entrance as possible, and not a bee will take wing if it is done quickly.

There is also another and easier way whereby the final " throw-out " is avoided—to the no small benefit of the novice's nerves!

The skep is placed on the sloping board in its natural position and the canvas untied quickly, laying the ends of it flat on the board. A smart jar on the top of the skep now will lump all the bees in a heap, from which the skep is lifted. The

" march-in " will then take its normal course, and the few bees left in the skep can then be shaken out easily enough.

As bees normally creep uphill, the reason for the inclined board is demonstrated, and almost certainly they will travel right into the hive without persuasion. If this should be needed, however, on an off chance, a few bees can be pushed towards the entrance with the finger, a bit of wood, a spoon, or anything handy. They never sting at such a time, and liberties may safely be taken.

Immediately the opening is discovered, the foremost bees will expose their scent organs, fan with their wings, and march in, followed by the remainder; their contented hum being responded to by all the others.

If in a Box or Package

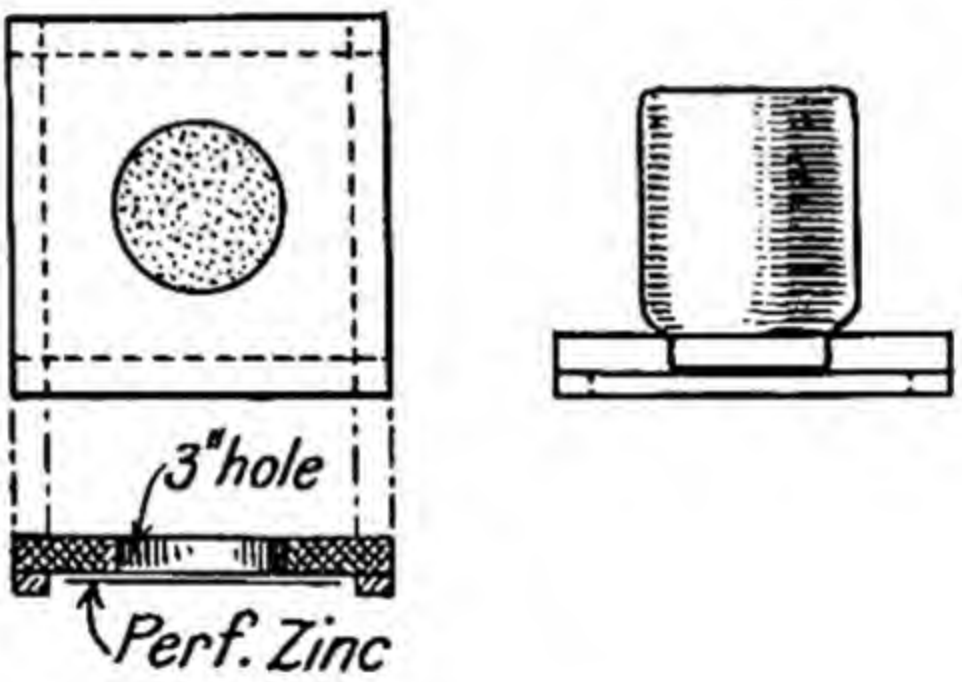
If the bees arrive in a box or " package," the principle of the procedure is the same—the feeding, inversion of the box to get them away from the lid, the bump, and the " throw-out." It is simplicity itself.

Feeding a Swarm

If the bees are hived on wired foundation, it must not be overlooked that they cannot all be at work drawing out the wax into cells and at the same time foraging in the fields. It is therefore advisable, for a week at least, under normal conditions, to keep them supplied with sugar syrup—two parts water to one part white sugar, lump or crystallized, beet

or cane. This will enable them to provide the waiting queen promptly with laying room, and assist them to start off their domestic economies under the best conditions.

Special bottle feeders with a graduated supply arrangement can be bought of any dealer for about half a crown. A good substitute can be made, however, with little effort, by the adaptation of an ordinary screw-cap bottle such as sweets are packed in, or any of the patent foods.



A piece of wood about 5 inches square and ½ inch thick has a 3-inch hole cut or bored in the centre with an expanding bit or a "pad-saw." A rim is formed on one side by nailing ½-inch by ⅜-inch thick strips around the edge to allow bee-space. A piece of perforated zinc is tacked on the same side to cover the hole (see above). If now a screw-cap bottle has one hole one-sixteenth of an inch punched in the centre of the lid, it will be found that when it is filled with syrup and inverted on the

perforated zinc, it will provide that slow steady feed which is at once the best incentive to egg-laying and comb-building.

In use, this feeder is placed over the 3-inch hole cut in the wood quilt which is recommended for use with the "Stoney-Archer" hive, and there is no disturbance or escape when the bottle is removed for refilling.

But, with the wood quilt, even this trouble is not necessary. If a piece of perforated zinc is laid flat over the feed-hole, the bottle can be stood direct on it and will thus function perfectly well.

NOTE.—It may be mentioned—although the need is obvious—that when the bottle is in use, it is necessary to have a lift of the same depth to stand on the wood quilt to support the deep hive cover. Col. Stoney-Archer uses a shallow feeding trough to push underneath the brood-chamber; but the writer has found the bottle and frame above somewhat handier for his own purpose.

Crowding the Bees

A day or two after a swarm has been installed on the new frames, it is well to open the hive and crowd the bees on to the number of combs they can cover thickly. This is done by placing unoccupied frames behind the wood dummy and so concentrating the work as much as possible on a limited area. The small but constant flow of syrup from the feeding bottle provides the stimulus to rapid comb-building and egg-laying, being the equivalent of a honey-flow outside.

If the weather is fine and warm, and flowers are plentiful, the necessity for bottle feeding will soon lapse. As the brood nest expands, the additional combs may be placed cautiously one at a time in the centre of the drawn ones until the whole are brought into use.

The idea is to produce bees. The surplus will take care of itself later if the season is not too far advanced.

V

THE PRODUCTION OF HONEY IN "WORTH-WHILE" QUANTITIES

Skep Days

In the early days of the skep, bees were left severely alone until the end of the honey-flow. If, in the meantime, they swarmed—as they would do if they were worth anything at all!—well, they swarmed, and that made a new colony, or perhaps two. They swarmed chiefly because the one set of combs used for everything had become filled with honey and pollen and brood, and because the queen had nowhere to lay her eggs, and because the skep had become too crowded for comfort.

Of course, with the exit of the main working population, the collection of nectar came to a standstill for a time (mostly in the very height of the honey-flow!), as it does now in a movable comb hive when it is similarly mismanaged. And then, when the hatching brood had become old enough to begin field work, there was little to do. The fragrant clover had browned; the blackberry was

fruiting; and even the stinking ragwort was getting shabby.

Then some evening a hole was scooped in the ground and sulphur was set burning in it. The skep was stealthily lifted off its stand and plumped over the suffocating fumes. There was a loud buzzing—a note of dire alarm, *crescendo* to *diminuendo*—followed by a ghastly silence as the stiffening corpses of the " bee-keeper's " little friends pattered down from their combs—the combs they had built with such labour—and stifled the blue flames with their numbers.

The combs were broken from their hold on the skep sides. The outer ones, of translucent amber, were laid out on a dish, the cappings bruised, and allowed to drain. The inner, a mingled mess of pollen, dead grubs, newly hatched bees, and some honey, capped and uncapped, would be put in a muslin bag and squeezed between the hands or with a pair of hinged boards. Horrible! But " what the eye didn't see, the heart wouldn't grieve! " The product looked all right, carefully strained, and in a nice jar labelled " Pure English Honey."

Growing intelligence eventually made some advance on this. A small hole was opened in the top of the breeding skep and a lesser one planted on top of it. The bees, quicker in the uptake than their owners mostly, grasped the idea promptly, and utilized the upper chamber as a store for honey only. The queen, always averse to " the narrow way," rarely mounted aloft. And so out of this idea was evolved the modern " super."

The Frame Hive

With the advent of the standardized frame hive, the provision of storage supers became a necessary part of the construction, the equipment being designed to keep separate the purely domestic offices from the common store.

But now there was only allowed a $\frac{1}{4}$-inch or $\frac{3}{8}$-inch "bee-space" between the top bars of the brood-combs and the bottom bar of the storage super above, and the queen, ever in search of more laying room, could not be persuaded easily to discriminate. She would use the "still room" for a nursery. The bee motto is "Excelsior," and true to it, she was ever climbing upwards.

The Queen Excluder

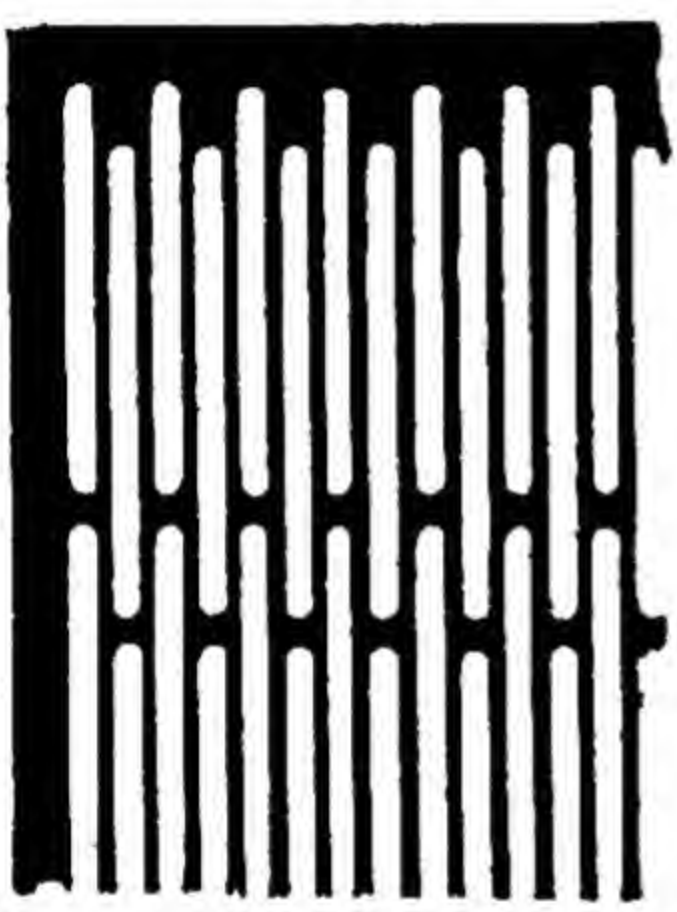
Therefore the superior mind of man was called on to invent something to keep the lady in her own place.

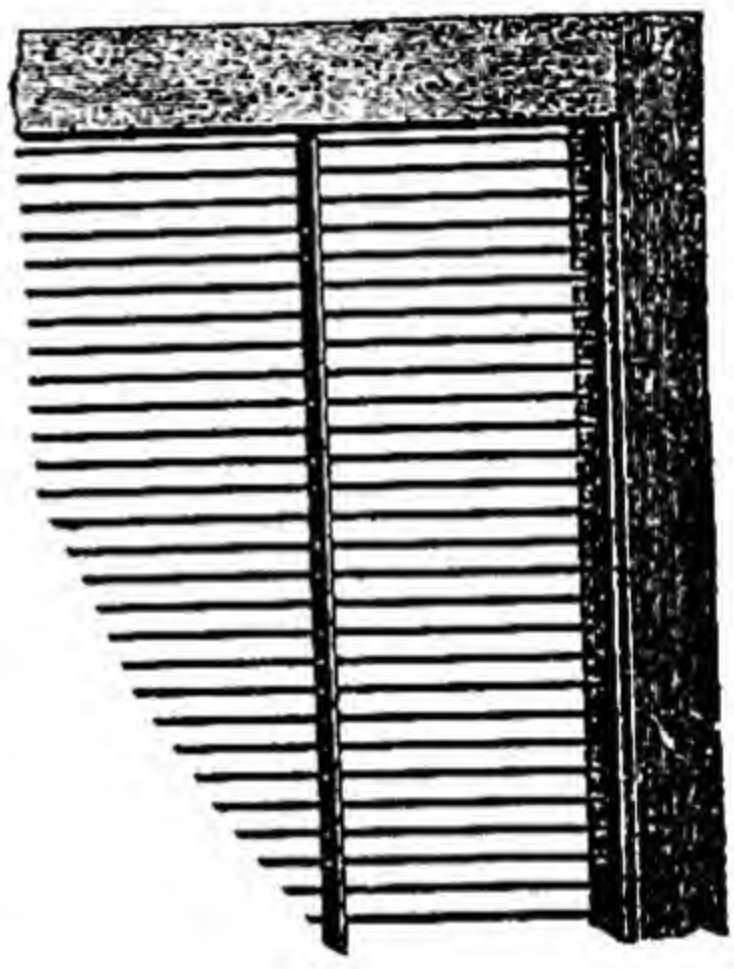
A flat sheet of zinc was punched with slots of just such a width (5/32 inch) that neither queen nor drone could pass through it, while it offered little impedence to the ascent of the workers. When the extracting supers were put on, this excluder was laid over the tops of the brood-frames, and thus the upper storey of the hive was kept free from brood, and was devoted entirely to the storage of honey.

As some objection was found from the fact that in punching out the slots a slight burr was raised on one side of the zinc which added somewhat to the "wear and tear" on the wings of the bees when dragging themselves through it, an advance

was again made by spacing smooth tinned wires between stiff metal spacers.

This pattern certainly offers little or no obstruction to the workers passing through, whilst providing far more ventilation with less liability to buckle. The latest "wood and wire" style is practically perfection.





And yet, as with most other things, there is division of opinion as to the value of the excluder, the "pros and cons" of which must be dealt with in due course.

Surplus—The Problem

Given a strong, healthy colony, a suitable hive, and normal weather conditions, how is one to obtain the greatest possible amount of honey in either the form of extracted or section?

It has been explained previously that, when living in a natural state or in a neglected hive, a colony of bees will work itself up to a certain strength and will then almost inevitably swarm.

Now, seeing that swarming is the exercise of the natural colonizing instinct, and that as doubtless it has been evolved through long ages of adaptation to circumstances where an error of judgment might have led to the extinction of the species, it is to be expected that for obvious reasons it will only be practised normally under the most favourable conditions, such as at the beginning of, or during a honey-flow. This being so, most obviously the breaking up and dissipation of the working force at this time is a misfortune from the honey producer's point of view, whatever it may be from the bee's, even if not a bee is lost in the general count.

One strong, contented colony working on established combs is worth for immediate honey production an unlimited number of swarms just beginning their housekeeping duties.

It follows, then, from this that the solution of the "problem of swarming" is also that of the economic production of honey in the greatest quantity.

A Strong Colony

We postulated a *strong* colony. What is a strong colony?

The average bee-keeper would say that when a colony is covering ten British Standard Frames on both sides in May, it answers that description.

Mr. Arthur M. Sturges, B.Sc., one of our best known authorities, on the other hand, suggests the following definition:

"A strong colony is one which has in its brood nest sufficient space available to accommodate the egg-laying of a queen of at least average prolificacy, and which has sufficient bees to enable the queen to work to her full capacity."

And he adds to illustrate this:

"A stock of twenty British Standard Frames should be considered as of the *minimum* strength suitable for supering, as below this, economical work cannot be obtained, and swarm control cannot be effective."

If "union is strength" there can be little doubt that Mr. Sturges' colony is the ideal for lesser mortals to aim at. And that brings us to immediate grips with our subject:

How to Get and Keep the Strong Colony

If in spring a colony of bees is left entirely to its own devices, the rate at which it will build up will be in accordance with the weather conditions. The egg-laying of the queen is governed, to all intents and purposes, by the presence in the combs of new nectar or uncapped stores. She is stimulated to lay or retarded in her laying by the supply of predigested food fed to her by her attendants. If fresh nectar and pollen are being brought into the hive from the fields, it is good evidence of the advance of summer—the season for storing—and egg-laying proceeds apace. If a period of bad

weather intervenes, this has its effect on the egg-laying. In this way such a colony will arrive at the summit of its strength *during* the honey-flow. In the expressive words of Mr. Sturges (*Swarm Control and Comb Honey Production*): "It will have built up *on the flow* instead of in advance of it."

The stores that should have been accumulated for "surplus" will have been used up in brood-rearing. And so, when the inevitable swarm occurs, there will be left in the hive only sufficient food for the wintering of a normal colony. Any honey taken away will have to be replaced by its equivalent.

That, in effect, as we have seen, was the skeppist's idea of honey production, and in most cases it also appears to be the practice of the man with a few frame hives even now.

The practice of the successful bee-master is so to control his bees, and to stimulate them to brood-rearing by artificial feeding *at the right time*, that when the honey-flow commences, he has *at least* two Standard brood bodies to each hive, filled to overflowing with contented, work-hungry bees.

To arrive at this culmination of his efforts, his work began with the close of the previous year's honey-flow. His spring preparations actually commenced in the previous autumn!

Re-queening

Under this controlled system of bee-keeping, a careful record is kept of the performance of each queen, and if she and her progeny have given

substantial proof of their ability to cope with modern requirements, a young queen is reared from the same stock to carry on the good work. The exchange is made towards the end of the main honey-flow, the old queen being either killed or put into a nucleus to lay for a few weeks longer. (The author's method of doing this is explained under " Manipulations for Swarm Control " later.)

Under the intensive method of modern bee culture a queen is rarely able to keep up to standard a second season, and, unless there is otherwise some exceedingly strong reason, she should not be kept.

The introduction of a vigorous young queen at this time, whilst nectar is still coming in from the fields, leads to a strong resumption of brood-rearing, and presently the inner combs are solid with capped brood. If the ever-lessening food supply is now supplemented by the use of a slow bottle feeder, this laying will be continued for some time, and the stock will be ready to go into winter quarters with a teeming population of vigorous young bees.

The old bees, hatched earlier in the season, will gradually die off in the natural order of things, and unless this young brood is provided for, a really strong spring colony is an impossibility. Hence the necessity under modern conditions for the late-reared brood and the teeming winter cluster.

Preparing for Winter

With a good queen and proper super accommodation during the collecting season, there will not have

been much honey stored in the brood-combs. The outer ones may be heavy, and some capped food may be found below the top bars, but generally speaking the need for the supply of sufficient winter stores will be apparent on examination.

Syrup for Winter Stores

Towards the end of September (earlier by a fortnight in the North of England) at least 15 to 20 lb. of sugar made into syrup by the addition of water should be fed to each colony as quickly as the bees will take it down. A good reliable recipe for this is:

Sugar (white granulated), 5 lb.
Water, 2 imperial pints (equal to $2\frac{1}{2}$ lb. by weight)
Tartaric acid, $\frac{1}{4}$ teaspoonful (or a tablespoonful of vinegar)
Bring to the boil, stirring to keep from burning, and boil for five minutes.

Boiling with the acid is to partly invert the sugar, that is, to change it into grape sugar and so to render it less liable to crystallize in the combs.

The dealers sell "rapid feeders" for use at this time of the year; but, if economy is the order of the day, the syrup can be put in 7 lb. canisters with push-in lids, or bottles with screw caps perforated with holes (seven or eight jabs with a bradawl will do) inverted on a piece of perforated zinc over the feed-hole. The essential is to give it warm so as to raise heat in the hive. This will lead to rapid sealing of the stores.

If there is any doubt as to the hive being fully provisioned for the winter, it gives a feeling of assurance to put on over the feed-hole a good solid block of candy made up in a "tongue or potted meat glass," such as one gets from the grocer filled with those comestibles. This shows at a glance when the candy is done, and meanwhile helps to conserve the heat of the hive under its dome.

The simplest recipe for making candy is given in a later section under "Data for Reference" (q.v.).

Winter Packing and Protection

"The best winter packing for bees is bees," is an old bee-man's saying well worth remembering and even "making a song of." A half-populated hive in winter must of necessity require more warming to keep it healthily habitable than one in which the cluster covers a wide and deep area. A host of young bees hatched late in the season (as previously described) is, therefore, the best preparation for the coming year.

The Production of Heat

The honey bee does not completely hibernate in the same sense that humble bees and wasps and butterflies do. In these cases the insect goes into its winter quarters fully fed. Its vital functions thereupon become reduced so near to the "verge where life and death meet" that it can exist in a dormant state safely through months of varying cold and privation without the necessity to eat or

drink. Its existence depends on the accumulated vitality within its own body.

The honey bee, on the other hand, depends for its survival on the co-operative collection and hoarding of stores and the communal use of the same during the winter.

This, however, is but the business side of the question—the storage of fuel which, in effect, food is.

The practical interest to us lies in the method by which the fuel is used to generate heat, and the way in which that heat is conserved. Rightly used, this knowledge is of the utmost importance in successful Honeycraft.

The bare facts of the subject may be stated in a few words.

For the satisfactory wintering of bees a certain degree of temperature is a necessity. Temperature within the hive is relative to that outside. As the outer atmosphere grows cooler, steps are taken by the bees to raise that inside. Heat is produced by muscular activity, by movements of the body, or the rapid fanning of the wings; and this exertion can only be sustained by the consumption and perfect digestion of suitable foods.

The Cluster

So long as brood-rearing is in operation, the activity of the bees in attending to their duties has kept up a steady internal heat. As this comes to a close, however, and the temperature begins to fall in relation to that outside, a cluster is formed over the position occupied by the last emerging brood.

The cluster consists of a more or less hollow sphere formed of several layers of bees. The empty cells within the sphere are mostly occupied by individuals which have crept head first into them and there rest inactive.

As the outer temperature continues to fall, increasing movement takes place in the cluster. A constant change of position occurs in the individuals, those from the inside continually changing position with those outside. Those inside, which, during their last temporary occupation of the outer ranks had obtained a supply of food, now become the heat-raisers—the "internal combustionists" of the cluster. And so, throughout the winter, by this movement the population defies the cold, and, as the storage cells are emptied of their food contents, the cluster moves its position about the combs to keep in contact with food supplies.

Practical Considerations

Carefully reviewing the various points traversed in the foregoing section, it would appear that for a favourable wintering and a profitable harvest the succeeding year, the following are essential requirements to every hive:

(*a*) A young and vigorous queen of the current year's breeding and of carefully selected strain.
(*b*) A teeming population with a large proportion of autumn-hatched bees.
(*c*) A minimum of 30 lb. of suitable stores.
(*d*) A weather-tight and well-insulated hive.

Items (*a*) and (*b*) need little reference further; but it may be pointed out that (*b*), (*c*), and (*d*) are closely co-related in their results.

It has been shown that the vital heat of the hive is raised by muscular effort stimulated and sustained by the consumption of stores; and that it is conserved by the formation and density of the cluster.

It follows, then, that the greater the number of bees, the easier it is to conserve the heat; and therefore the less heat that is dissipated the less will be the food (or fuel) required to raise that heat. In other words, the bigger the stock wintering, the less ratio of stores (and cost) is needed to sustain it.

In simple English, then, "the best winter packing for bees is bees."

As an adjunct to this, of course, item (*d*) is an important factor—the insulation of the hive.

In an earlier section the "Stoney-Archer" type of hive was described as the author's ideal of simplicity, economy, and effectiveness, and its construction and good points were dilated on.

For safe wintering, Col. Stoney-Archer (the originator of the hive) advises the use of what he calls a "roofing felt petticoat" which completely covers the body box (or boxes) from top to floor-board. In the case of a hive with two brood-boxes, a length of "Pluvex" or other similar bitumen felt 75 inches long by 18 inches wide is required, or, for one body box, 9 inches wide. This is stretched tightly around the hive (with the lid off) and fixed with a few drawing-pins. When the deep lid is put over it, perfect protection is given against "rain,

snow, or blow" from every quarter. A further suggestion is the use of a piece of the felt 13½ inches by 16 inches for slipping inside the hive to cover the floorboard. The great advantage of this is that it catches all the waste cappings, dead bees, and any condensation that may result, and that in spring it can be drawn out at the front or back of the hive without disturbing the bees, leaving a perfectly clean and dry floorboard. This, of course, saves the unpleasant task of scraping and brushing the latter at a time when such disturbance is undesirable. The " petticoat " should not be removed until " May is out."

Size of Entrance for Wintering

The size of the slot cut in the entrance block bears a ratio to the strength of the stock and the material of the quilt covering the top of the frames. Col. Stoney-Archer suggests in his *Bee World* description of the hive that a square of roofing felt should be included in the top packings, and in this case, he apparently suggests a 2-inch by 5/16-inch entrance hole. When using the wood quilt previously described, with the feed-hole covered with a sheet of glass and a few thicknesses of newspapers and carpet squares above, the author has found that a 3-inch by ⅜-inch hole is about correct, little condensation being apparent. Using porous coverings above produces a slow ventilating current below which must be corrected by a less entrance. An impervious felt above will allow for a relatively wider ventilating entrance, because there is little

or no escape of top heat with its consequent inrush of cold air below.

Simmins gave instances of successful wintering with no quilts at all above the frames, and a 6-inch entrance below in his own particular choice of hive.

Apparently there is room for experiment, but this should be done with caution. Bees are strangely conservative in their habits, and one is led to wonder sometimes if, in points of ventilation, for instance, their inherited experience is not often a better guide than our reason. If the feed-hole in the wood quilt is covered with perforated zinc, and this again with porous material, the bees will make a special point of carefully filling up every perforation with wax or propolis. The wood quilt itself is most thoroughly sealed down all round to prevent escape of heat. In some instances the entrance hole may be built up with wax and propolis to reduce it.

The principle at issue is to preserve a healthy balance between the irradiated heat of the cluster and the cold outer atmosphere, so as to avoid excessive up-draught and internal condensation.

Spring Operations

Granted the conditions enumerated, a healthy stock should have come through the winter strong and vigorous. On the rare calm, sunny days that come in February, individuals will be seen bringing in water or scrambling for the entrance with loads of fresh pollen from the early flowering plants, gorse, crocuses, and what not. At this time a slab of soft

candy placed gently over the feed-hole and renewed as needed has a wonderfully stimulating effect.

If the piece of glass covering the feed-hole has been smeared with vaseline or medicinal paraffin before putting in position when packing up for winter, the bees will not have been able to stick it down, and it can be slid on one side easily and the candy put on without disturbance.

Until the winter cluster is broken up by warm weather, all causes of disturbance should be avoided completely. Upset means excitement, and a bee's remedy for that is either bad temper or " the flowing bowl," neither of which is good in excess while bad weather conditions are likely to prevail.

Artificial Pollen

It was (and probably still is) an article of faith with the old bee-man that, at this period, the use of pea-flour, in the form of artificial pollen, sprinkled in the open calyxes of crocuses, or otherwise employed, acted as a stimulant in brood-rearing; but some reasonable doubt exists on the efficiency of the practice. In a district where early natural pollen from the gorse is available in quantity, however, all substitutes will be ignored, and brood-rearing will go ahead at a great rate. Indeed, in such a district there is no object in giving artificial pollen at all. Where gorse flowers in the spring it will also have flowered late in the previous back-end—one may say, almost, it never entirely ceases flowering. In Sussex, at all events, that is true, and one may even find the flowers gilding the prickles at

Christmas. Therefore it is quite safe to say the stock combs will always have fresh pollen available for brood-rearing, and only abnormal weather conditions can slow down the process.

Wheat flour is best avoided in all hive operations, as it mostly dries in the cells into solid pellets, which can only be removed by the bees cutting the cell walls away to the mid-rib. This is usually followed by a first-class crop of drone cells built on the foundation, to the detriment of otherwise good combs.

The objection to most of the popular pollen substitutes appears to be the great percentage of starch they contain, which, according to Dr. Phillips, the bees cannot utilize as food.

Speaking broadly, it would appear that, in a district where there are no early flora and pollen supplies to depend on, it is far more profitable to leave natural conditions in the hive undisturbed until they are wakened up by the advent of spring. The first gathering of the real pollen will well make up for the slight delay. Abnormal breeding means abnormal excitement, and the untimely using up of the old bees' vitality before the young brood can make the internal compensation.

Water Supplies

At this time of the year a great deal of water is needed in the hive for brood-rearing. It is a necessity that should be provided for by every practical bee-man. A vast amount of energy and wear and tear in wings may be saved by the provi-

sion of a good supply close to the hives. Unless this is given, a great many valuable bees will be lost in getting their loads from ditches, ponds, or streams, besides the added risk of bringing infection from polluted water.

The supply need not be anything elaborate. A clean paint tin with push-in lid may be punctured slightly and hung up, or stood, so as to leak on to a gently inclined roofing slate. If this is fixed in a sunny corner out of the wind, the constant procession of bees will be the reward for the little trouble involved. If any difficulty is experienced in forming the habit, a little salt or honey put in the water for a day or two will prove an incentive.

A wide-necked bottle inverted over converging grooves cut into a slate stood on a plant pot also makes a reliable fountain, giving a constant supply without danger of drowning.

Spring Feeding

Towards the end of March, if the weather is favourable (as it is in the average then), great assistance can be given to the expansion of the colonies by putting a bottle feeder over the hole in the wood quilt and feeding slowly *from one hole only* a thin syrup of

Sugar (granulated) 1 part by measure
Water 2 parts ,,
(a pinch of salt seems beneficial)

brought to the boil and allowed to cool before feeding.

This is to be used as a stimulant only for brood-rearing—not for storage!—and on this account must be fed slowly and constantly when once started. The effect of this in the hive is the same as would result from a light honey-flow outside, and as supplementary to the early pollen which will be coming in from the sallows, wallflowers, gorse, etc.

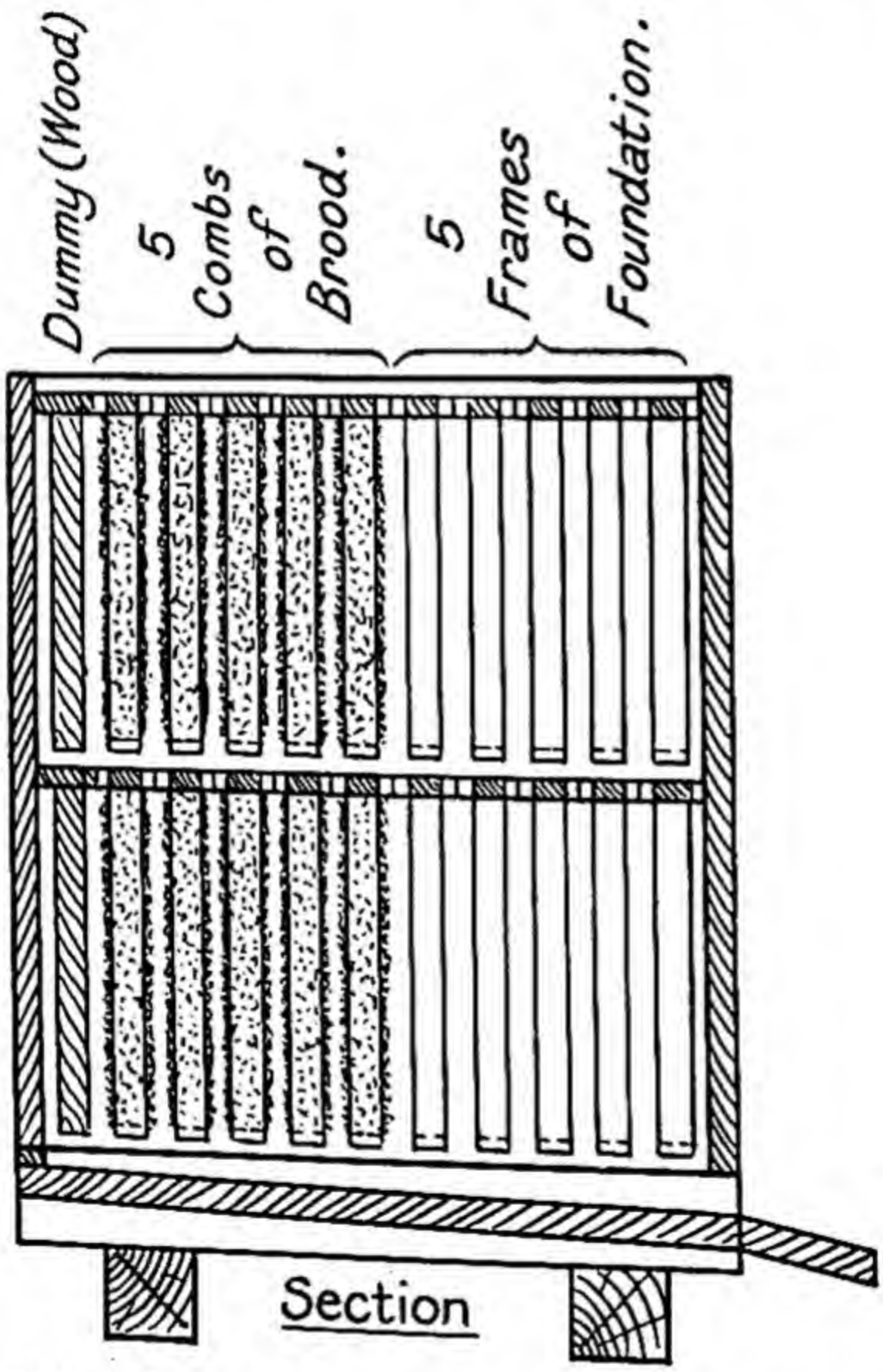
If the colony is headed by a young queen and was prepared for wintering as suggested, no uneasiness need be felt as to the condition inside the hive. Beyond removing (and afterwards replacing) the back entrance block (described in the construction of the hive) and gently drawing out the floor covering with its winter debris so as to leave a clean, dry floorboard, no manipulation is necessary or even desirable until well on into April.

The one great consideration is to build up the colony to its greatest magnitude well in front of the main honey-flow. This in itself is one of the strong preparatory points in the avoidance of swarming, strange as it may seem. In any case, one need not feel any apprehension of swarming happening until well into May in an ordinary district.

Supplying Fresh Breeding-Combs

If the colony has been wintered on one set of ten brood-combs, it may be that signs of overcrowding will become apparent by the middle of April. In that case, an examination should be made about noon of a sunny day, and if the combs are found to be filled with brood and well covered with bees,

another brood-box, with old combs, if possible, should be placed on the stand underneath the other body. This will be occupied by the queen in due course as she finds the need for further laying room,



and a natural expansion will continue up to the time of the main honey-flow.

If, however, no empty drawn combs are avail-

able, an exceedingly good method is to proceed as follows:

A second brood-box, filled with wired foundation, is placed on a stand close by the one to be operated on. The latter is now opened, and the comb containing the queen is removed and placed somewhere out of harm's way for a few moments. Five of the full combs are now exchanged for five of the undrawn ones and placed altogether at the back of the new body, the new combs being placed in the front part of the old body. The comb with the queen is now replaced with the remaining four towards the back of the old body on the stand, and the new body lifted on top of the old one so that the five full combs of the new body are above the five full combs in the old body at the back of the hive. (See p. 139.)

This rearrangement gives a deep brood nest which conserves all the available warmth, and from which the bees can work forward, gradually drawing out the foundation of the new combs.

Continuing Stimulation

Until it is evident that the incoming honey, due to the advancing season, exceeds the daily consumption for brood-rearing, gentle feeding should be continued. A few pounds of sugar expended at this time will be amply repaid later.

Clipping the Queen's Wing

This is an operation which is much more practised and believed in abroad than it is in this country. There can be no question about its value from any

point of view. It is an idea dating as far back as Virgil's *Georgics*, and is as beneficial as the latest result of scientific research, especially to the man who cannot be with his hives all the time.

It will not cure the swarming impulse, but it may often be the means of saving an unexpected swarm from being lost in the absence of the owner; and it will mostly avoid the mess and worry of skepping and returning a clustered swarm.

Spring is the best time for the operation, as, for one thing, the queen is easier for the novice to find, and for another it is taking (swarming) "time by the forelock."

It is best performed by lifting the comb the queen is on out of the hive and standing it up somewhere so as to leave both hands free.

Wet the tip of the index finger and follow the queen steadily around with it until the opportunity is found of putting the finger gently on the thorax. The wings will stick to the wet finger and the thumb will close on them and she can be lifted off the comb. She will not sting, only struggle.

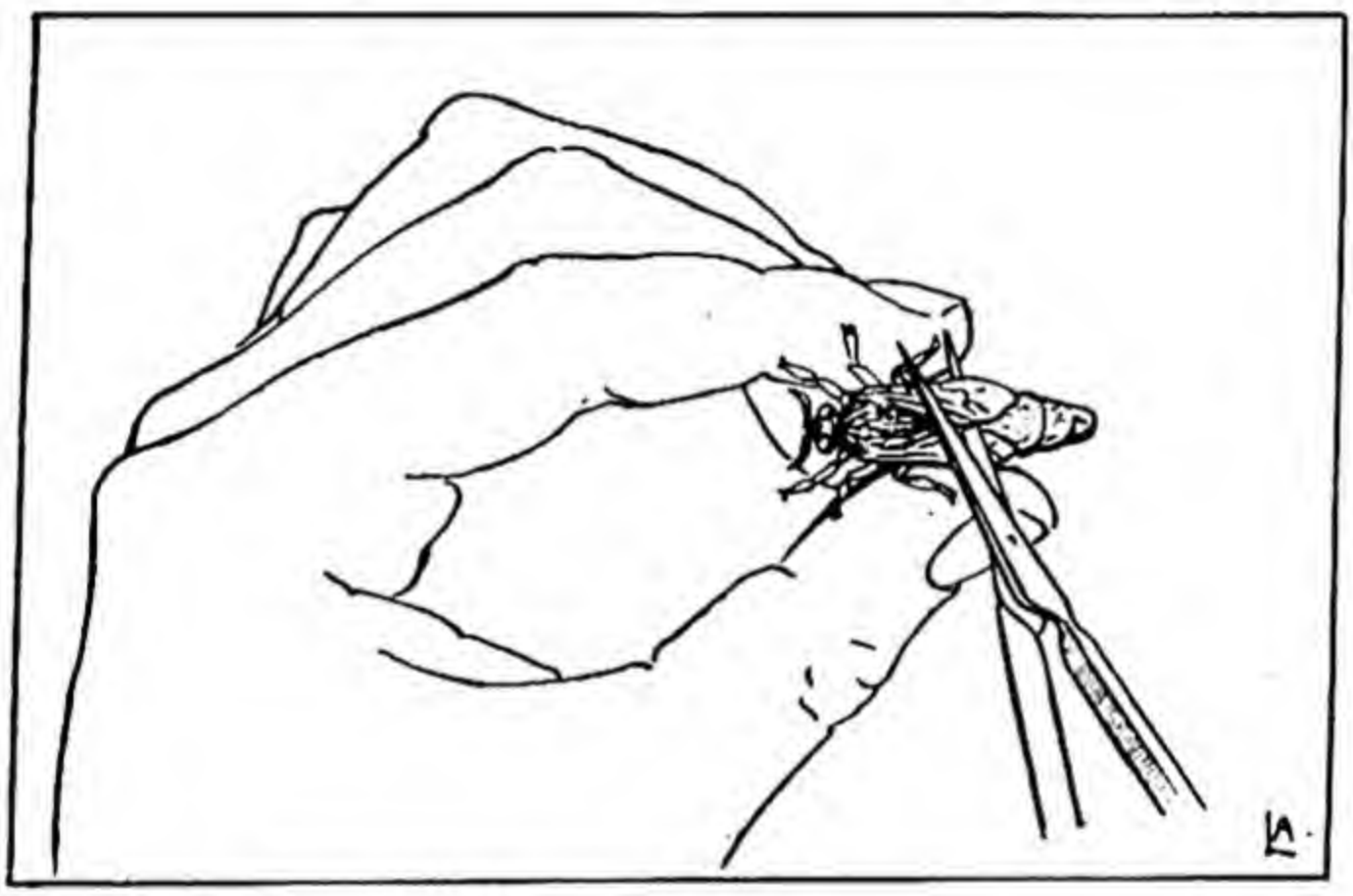
Pass her into the thumb and index finger of the left hand, which will hold the sides of the thorax firmly, with her legs resting on the second finger. *Most carefully avoid squeezing her body!*

Now, with a pair of fine-pointed scissors clip about half of both wings *of one side only*. Remember a bee has four wings in two pairs—anterior and posterior (front and back in plain English). If they are cut slantwise, so as to leave as much as possible of the front thickened rib (the "costal nervure"

of the entomologist) and as little as possible of the web, it is an advantage.

Now, pick up the comb and let the queen run from the fingers on to it before replacing it in the hive. Do not drop her, as the abdomen containing the all-important egg-producing organs is very susceptible to injury.

The result of the operation is to prevent the queen



taking flight with a potential swarm—and she knows it when the chance comes!

A swarm may come out. It may fly all over the neighbourhood and finally cluster, but immediately it recognizes the queen is not with it, it will return promptly to the hive it has left.

In the meantime, if the queen has not returned to her combs disgusted with her wings, she will most probably have dropped off the alighting board to

the ground, where she will be found with a small cluster of her subjects around her awaiting events. If now she is slipped into a matchbox and put in the waistcoat pocket while the hive is gone through and the causes of the disturbance adjusted, she may be gently dropped later into the midst of the returning swarm and so up to her deserted combs.

There is, of course, the "off-chance" that she may have crawled away and got lost. That is unfortunate, but not irremediable. If the one best shaped of the queen cells on the combs is left when cutting out or disposing of the others before the swarm returns, the colony will accept the situation and rear for themselves a new queen. The break in the chain of egg-laying will have effectually disposed of swarming, and so little practical difference will result in the gathering of the crop.

VI

SWARMING AND ITS PREVENTION

Swarming Time

Recognizing that *profitable bee-keeping is dependent on strong, industrious colonies,* our aim hitherto has been to reach the condition well ahead of the main honey-flow on which our year's success depends. So far, we have not considered seriously whether honey was being stored in the combs or used as food for the brood. Our aim has been to get bees and yet more bees in readiness for the opening of the real harvest that comes in with the clover.

With one eye on the teeming hives and the other, so to speak, on the fields, we have waited anxiously for the first few creamy heads to rise above the green carpet of trefoil leaves, and now that the critical moment has arrived, how shall we meet it?

We are face to face with an inexorable law as old as the first successful bee colony—the instinctive desire to swarm under the most favourable conditions.

We do not know precisely how the first direct movement is inaugurated in the colony towards this

end, but we do certainly know what the state of the hive is at that time. Reasoning after the manner of Science, " from the known to the unknown," the researcher has now made it possible for us to recognize and so avoid that condition arising in the hive, which is the invariable precursor of the swarm. By an intelligent application of the knowledge we can now almost (if not quite) completely banish the upset and consequent loss which has been the worst bug-bear of Honeycraft.

Swarming Conditions

If, during the period of swarming, varying slightly in most districts, a hive is opened and is found to be getting ready for this action, which may be recognized by the presence of queen cells in varying degrees of progress, a thoughtful inspection will reveal some or all of the following conditions:

(*a*) Brood-combs solid with brood in all stages of development; large patches of drone comb, whose raised cappings help to reduce the bee-space between the combs; misshapen combs which tend to the same trouble; many cells choked with pollen and capped honey, the queen in consequence having nowhere to continue laying.

(*b*) A disproportionate host of young nurse bees tending the developing brood, and so congesting the alleys and bee-spaces and preventing the free passage of the field bees in and out.

(*c*) Bad ventilation caused by narrow entrance and too small a bee-space between floorboard and bottom of combs—the result of shrinkage or bad design of hive.

(*d*) The non-provision of a proper $\frac{1}{4}$-inch bee-space above the brood-combs, and the consequent choking of the punched-out zinc excluder by the attachment of brace combs from bottom bar of the super combs or top bar of brood-combs.

(*e*) Badly designed section rack and use of bent or twisted separators, and (in some cases) use of excluder along with section rack—a totally unnecessary precaution.

Swarm Control and Manipulations

Intelligently recognized, it is an easy matter to overcome in most hives the mechanical defects mentioned in (*c*), (*d*), and (*e*). But the adoption of the "Stoney-Archer" type of hive made to the details shown in an earlier section will effectually obviate all these troubles, besides being a joy to work with.

It is to correct the consequences of (*a*) and (*b*) that a new style of manipulative technique has been found necessary, and which in one way or another has been adopted in the various successful methods of swarm prevention to be described.

In the early literature of bee-keeping one can see a glimmering of understanding of the real underlying causes of swarming. In one way or another every earnest bee-man had developed a personal

method of meeting the difficulty, if only by delaying it for a few days. But more or less it was generally felt to be inevitable, and the real advance seemed to be on the lines of " making the best of a bad matter " after it had occurred.

In a standard work, which probably has had more influence in recent years on the average bee-keeper's knowledge, under the head of " Preventing Swarming " one can only find such advice as " give room a little in advance of requirements "; " cut out and destroy queen cells "; " support the brood-chamber on 1-inch blocks of wood for ventilation "; " take away all the brood and distribute it to other hives "—no direct grappling with the underlying causes.

Undoubtedly the most important advance in our knowledge of swarm causes and methods of controlling the same was published by the U.S.A. Department of Agriculture in a bulletin from the pen of the famous expert, Geo. S. Demuth. In this paper he reviewed all the known methods of control with his own summing-up of their respective values, a study of which is certainly a " college education " for any serious bee-man. Its forty-six pages are packed with information, unique and authoritative. (Farmers' Bulletin 1198, U.S. Dept. Agriculture, "Swarm Control," by Geo. S. Demuth.)

The net result of these investigations appears to be that, in one form or another, manipulations must be directed to the attainment of the one object:

" A temporary disturbance in the continuity of the emergence of young bees."

In other words, round about the period when swarming may normally be expected to occur, the brood-combs must be so manipulated that the queen shall be separated for a sufficient time from the bulk of the hatching brood and the young nurse bees, in order to interrupt the steady course of her egg-laying.

The honey-flow, during which swarming usually occurs, is of relatively short duration, and as it takes at least five weeks from the laying of the egg to the developed worker going out to gather nectar, viz.:

Egg	. . .	3 days
Larva	. . .	6 days
Pupa	. . .	12 days
		21 days
In the hive as nurse (say)		14 days
		35 days (5 weeks)

it is apparent that eggs laid immediately before or during the honey-flow are of no value to the harvest. If manipulation is not practised, and swarming is delayed by merely cutting out queen cells, these aggregated numbers produce conditions of overcrowding, bad ventilation, and a general discomfort that checks all progress in the hive.

A study of the following methods of manipulation will show how, by one way or another, the above

conditions are avoided so as to preserve the immediate strength of the hive, keep the working morale of the bees at top pitch, and yet, at the end of the flow, to leave the colony strong and fit for successful wintering.

VII

PRODUCTION OF EXTRACTED HONEY

The Demaree Method for Extracted Honey

The best known, and certainly the most practised of all swarm controls is the " Demaree " method, the mainstay of the big honey producer who handles hundreds of hives, and cosmopolitan in its popularity.

It is the easiest and simplest for the novice, and the quickest for the busy man. It is certain in its results, and can be worked with practically any make of hive which allows a standard brood-frame body to be used as a super.

Parenthetically, it may be explained here that, as all swarm-control manipulations demand the movement of brood-combs from one place to another, it is necessary that each hive should have at least two standard depth brood bodies in its equipment. Shallow extracting supers as well as section racks may then be used in between them as required.

As swarming time approaches, close watch must be kept on the hives, and as soon as the brood nest begins to get crowded enough to demand more room, a brood-box filled only with empty combs or

wired foundation is brought to the side of the hive which is to be manipulated. The hive is next opened and the comb of brood on which the queen is found is lifted out and exchanged for one of the empty combs from the other body.

The old brood-box is now lifted off the stand and the new one containing the queen is put in its place. A queen excluder is placed over it and the full body stood on that.

The queen has now been provided with an abundance of empty comb in which to continue laying. Her immediate surroundings, in fact, are nearly exactly what would have happened had she been put with a swarm into a new hive. She, and the old bees coming in from the fields, set to work with all the proverbial energy of a swarm, and when the honey-flow arrives in due course, a tremendous working force, with no further desire to swarm, is ready to make the best of it.

As the brood in the upper storey hatches out, the empty cells are used for the storage of nectar, and if additional room is given as needed, by placing another super of empty combs (shallow frames may now be used) immediately above the excluder, work will continue without interruption.

That, briefly, is the original Demaree method. In reading the description thoughtfully, it will have been noticed that it conforms to what was stated to be essential in any method of swarm control: the separation of the queen from her brood and the young nurse bees, and also the temporary break in egg-laying.

The hatching and developing brood now being at the top of the hive, the young nurse bees will have been drawn away from the queen. Her food supply now being restricted by the absence of her attendants above, her rate of egg-laying is (to that extent) also cut down in amount.

Re-Queening by Saving Queen Cells

It has been explained in an earlier section that, when a queen is removed or separated from a portion of her colony, the first impulse of the queenless lot is to rear another queen.

When, by the Demaree method, the queen is prevented by the excluder from visiting the upper storey of young brood, the same thing happens then. Ordinarily, it is necessary in a week or ten days after the separation of the queen and brood, to go through the combs in the upper storey to cut out the queen cells which have been started. But if it is desired to re-queen the hive from the same mother strain, it is a very easy matter to do this in a "Stoney-Archer" or similar hive by the use of the excluder screen illustrated.

The Excluder Screen—Construction

As will be seen, this is merely a sheet of perforated zinc cut the full outside size of the hive body ($18\frac{3}{8}$ inches by $17\frac{1}{2}$ inches) and framed both sides with $\frac{1}{4}$-inch plasterers' laths nailed right through with $\frac{1}{2}$-inch gimp pins. Two cross-bars of the same lath are fastened in with tabs of thin metal (cut from a cocoa tin) to prevent sagging. In the centre a

double Porter bee escape is let in and soldered to the zinc, while at the edge of the screen, which will come to *the back of the hive* when in use, a piece of queen excluder zinc or wire (about 2½ inches by 2 inches) is also let in and soldered. Two saw-cuts are put through one thickness of the lath frame, which is on the same side as the entrance of the Porter bee escape, so as to form a narrow, wedge-shaped flight hole *above the zinc*. The piece of wood cut out is to be kept to block the hole when not in use.

Any novice can make the screen, and it is one of the most useful gadgets about a hive.

Saving the Cell

If it is desired to save a queen cell when working on the *original* Demaree method described above, the comb containing the cell is lifted out and put along with one or more combs of hatching brood and some honey into an empty brood body. The screen is now laid over the top super with the excluder panel open, but the Porter escape hole covered with a piece of zinc or blocked with a cork to put it out of use. The brood body with the queen cell is next stood on the screen with the combs pushed back over the excluder panel and a dummy board put in front to keep the bees together and warm. The wood quilt crowns the lot.

The hatching brood will take care of the queen cell, and as there is free access through the excluder panel there is a constant change of visitors. The

young queen will hatch out in due course; will make her flight from the hole which will be opened in the side of the screen, and, getting fertilized, will start to lay in the combs she was hatched from.

Later, if desired, the old queen from below may be exchanged for the new queen, and will continue to lay up above and build up a new colony. At the end of the season she will be dispensed with.

The perforated zinc allows the heat to ascend, and the young queen is thus hatched and reared under the best conditions.

Screen as Super Clearer

The screen may also be used later as a super clearer after the loose piece of wood is put back in the frame to stop the flight hole, the escape opened, and another piece of zinc used to cover the excluder panel.

The Demaree Method—Variation No. 1

There are certain points about the original plan not altogether desirable in their effects. One disadvantage is the accumulation of pollen amongst the honey when brood-combs are used as supers. There is also the chance that some of the previous year's winter food may not have been uncapped and would tend to impair the quality or colour of the new crop.

It was to overcome these difficulties that Mr. Morley Pettitt, the Ontario bee-keeping director,

some years ago, suggested the use of an additional storey of empty combs (or two storeys if needed) between the bottom (the new brood nest) and the old one. By this means, it was found that the above-named disadvantages were overcome.

If it is desired to work shallow extracting frames, these may be used satisfactorily in between the standard frame storage bodies, and thus build up the hive more gradually.

Variation No. 2

The use of the excluder screen described above adds a further variation which is found useful at this point.

If the screen is placed under the topmost brood storey with the side flight hole open, the escape blocked, and the excluder panel in use, honey storing will be carried on in the supers below; the young nurse bees, as they become old enough for field service, will pass downward to join and strengthen the ranks of the foragers. A young queen may be reared and fertilized, and her resultant progeny will work both from the flight hole and in conjunction with the original stock below as long as they are left on the hive.

Variation No. 3

In his most excellent little work *Swarm Control and Comb Honey Production*, Mr. Arthur M. Sturges, B.Sc., develops what he calls the "Modified Demaree System," which is certainly *the* plan for producing and dealing with the

immense stocks he advocates—the three or more storey standard frame colonies which we lesser mortals may envy but cannot always rise to.

This modification on the old method is considered necessary by Mr. Sturges to make absolute certainty against swarming. With the prolific strain of queens he breeds, he claims that the one removal of brood is not sufficient to stop swarming; it must be a continuous process extending over several weeks until the slackening down of the honey-flow.

The gist of his idea is that by weekly manipulations he makes a constant interchange of combs from the bottom breeding-chamber (kept under an excluder) to the top storey; the second and as many more intermediate ones as may be necessary being used for storage. Each weekly interchange is to give the queen empty combs, old sealed brood, and uncapped honey (which will be cleared out and carried above), and to take eggs and unsealed larvæ up into the nursery storey at the top. This draws the nurse bees away from the queen to the top storey, keeps "Her Majesty" fully occupied, prevents overcrowding below, and, as Mr. Sturges says, "supplies a colony capable of storing ten or more pounds of surplus per day during a clover honey-flow."

It certainly prevents swarming; it creates an immense army of foragers; and, according to Mr. Sturges, it has "produced yields of over 250 lb. per colony in good seasons."

For more detailed particulars, the student is referred to the book mentioned above.

Dr. Miller's De-Queening Treatment

Working on the line of reasoning set out by Demuth, Dr. Miller, the famous American bee-man, procured the "temporary disturbance in the continuity of the emergence of young bees" by a system of de-queening.

When he had secured a large enough working force to deal with the honey-flow, and had it working in the supers, he caught the queen and confined her under a wire cage on one of the combs, where she could be attended by her own bees but was unable to continue her laying. Alternatively she was removed to a small nucleus hive where she could lay. While he was doing this, he destroyed all the beginnings of queen cells. At the end of ten days any further cells found were carefully removed and the old queen returned or liberated, or another fertile queen put in her place.

Here, it would appear, the use of the excluder screen is indicated. If the old queen, with a comb of hatching brood and another containing uncapped honey, was placed in a brood-box above the screen and super, with the escape closed and the excluder panel open, she would continue her laying there. Then, if the best of the resultant queen cells in the bottom box was left and all the others cut out at an interval of ten days, the colony would benefit by the "check to laying," would not swarm, would re-queen itself, and in the meantime would carry on its work in the super or supers as if nothing untoward had happened.

If the young queen had any accident in her first

flight, the old queen could be brought below again, and no swarming would happen because of the "temporary check to the emergence of young brood."

Col. Stoney-Archer's Plan

In giving directions in the *Bee World* for the use of the hive which bears his name, Col. Stoney-Archer begins operations from the view-point of a hive of one storey. He proceeds with his second storey in the manner described on page 140.

Supplying Fresh Brood-Combs

"When the frames in the second brood-box are completely drawn out and the upper portions sealed and covered with bees from front to back, put on a third brood-box full of frames of comb or foundation. When this is full, put on a fourth, and so on; in a good year it will be found that six brood-boxes may be required."

Col. Stoney-Archer does not countenance the use of queen excluders. "If the above instructions are carried out," he says, "nine times out of ten the queen will confine her attentions to the two lower brood-boxes, and the upper ones will be solid with honey."

It is not stated whether, in adding supers, they are put at the top of the last, but presumably this is so. In operating by the Demaree method, the new super is placed next to the excluder in each case.

As Col. Stoney-Archer has the reputation of

procuring "heavy takes" in a poor district, there is apparently much to be said for his methods.

The McNally System

Written in the *Scottish Bee-Keeper* under the initials "J.A." (whom most bee-keepers will recognize), this system is described as the "simplest possible," which "works well in practice" and might almost be called a "let-alone" method.

It was developed chiefly for use in Scottish out-apiaries, but it is of great interest also as a matter of comparison with the previously described methods of manipulation.

Each hive was left in autumn containing rarely less than 40 lb. of honey, and no other winter feeding was done. The owner (McNally) "did not go near the hives until about the middle of June, when the clover harvest opened." He then usually "found each hive full of bees with brood at least on eight of the ten combs." He placed *under the stock* a full-size brood-box with ten frames of foundation. His second visit was made when the two boxes were crowded with bees (the time being estimated by watching his home hives). Another box of frames filled with foundation only was placed "either right at the bottom or between the other two. . . . Worked in this way, McNally found that not 1 per cent. of his hives swarmed, and he also found that thirty combs would accommodate even the largest stock."

It will be noticed that the new supers were placed "*under the stock*," and the experience of "J.A."

was " that the brood, at first all contained in the first or uppermost box, gets gradually pushed downward until at the end of the season only the lowest box contains any brood at all."

Similarity of All Systems of Swarm Control

If the foregoing methods of manipulation for swarm prevention have been carefully studied, it will have been apparent that one principle underlies them all. If this point is intelligently grasped, it may be extended in many ways to suit special occasions and situations. When we apply it to " comb honey production," slight modifications may be necessary, but the gist of the matter remains the same. In any case, the results are certain and beneficial.

Removing Honey for Extracting

If honey is removed from the hive in an " unfit condition "—that is before it has been evaporated down to a certain consistency—it will almost inevitably ferment or turn sour and be unusable. If it is properly " ripe," it may be kept for twenty years without deterioration.

Scientifically, the specific gravity, density, or ripeness—whichever you choose to regard it as—of honey is most accurately tested by means of a hygrometer. A well-ripened honey should indicate a specific gravity of 1·42 at 60 deg. Fahr. If it registers below this figure, it is not considered sufficiently ripe for export by the New Zealand Board of Agriculture.

Generally speaking, however, the bee-keeper's

" rule of thumb " test, that the combs shall be at least two-thirds capped over before being removed from the hive for extracting, is sound enough for everyday use, and should be adhered to both from a point of business policy as well as for personal credit.

The super clearer.

The Super Clearer

It is customary when it is desired to remove a set of combs, to use a " super clearer " placed between the brood nest and the super. By means

of an ingenious arrangement of flat springs fitted inside a tin box, known as a " Porter bee-escape " inserted in a wood setting, a rack or super can be cleared in a short time without upset or excitement. The " bee-escape " provides a " one-way trail " from super to brood nest.

At all times within the hive, a bee likes to keep in constant and direct communication with the brood nest and queen mother, and if anything comes in the way of this, it gets uneasy. It is by working on this known feeling of the bee that the " Porter bee-escape " makes the super clearer the efficient instrument it is.

In the evening the super is gently lifted and the clearer pushed beneath it. By morning, every bee will have joined the stock below and the super may then be removed in comfort and safety.

The excluder screen (previously described) makes a first-class clearer when the panel and flight hole are blocked and the escape left open.

Brood in the Super

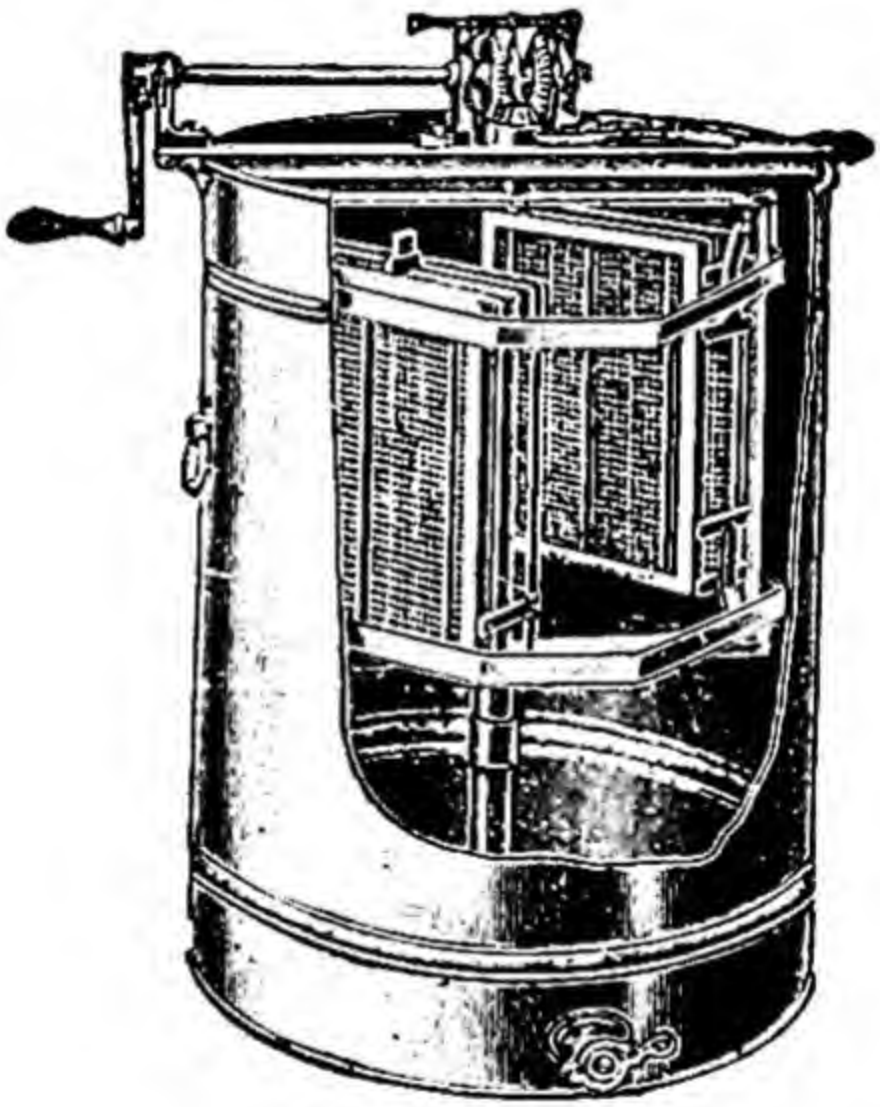
There is just one time when the " super clearer " won't clear. If it is put on without first having examined the super, and, hours after, bees are still found on the frames, you may depend upon it that there is some young brood where it should not be. In manipulations, it can easily happen that eggs have escaped notice, and what was wrongly taken to be an empty comb has found its way amongst the extracting frames.

The remembrance of this contingency may

sometimes solve a problem quickly. Bees will not forsake young brood at any time without providing for its welfare.

Extracting

The old skeppist had a considerable advantage over the modern frame hive man in the matter of capital outlay to render his produce saleable. The



Cowan design.

modern extraction of combs demands an initial outlay somewhat heavy on the man who owns probably only two or three hives, and it may be for this reason he prefers the uneconomical and relatively difficult production of a few sections to the far more profitable and easy line of run honey.

The price of a well-made extractor to take two Standard or two shallow frames, without gearing—such as will suit an apiary of six hives—is quoted at the present time at 47s. 6d., or with covers, 4s. 6d. extra. The same extractor, with gearing, which adds immeasurably to its utility and ease, is priced at 62s.

The "Cowan" design, with reversing cages, covered gearing and covers, etc., costs from £5 10s. to £12—dependent on size and complexities.

The benefits of the extractor are obvious, and as one lasts a lifetime, the initial capital outlay spread over years is insignificant when weighed against the increased production and added excellence of the product.

Briefly stated, the process of extracting is as follows: The frames of sealed honey taken from the hive have the cappings removed by the sweep of a heated knife. They are placed in the baskets of the extractor and the machine started. The centrifugal motion throws the honey from the side of the comb spinning swiftly around parallel to the side of the can, and it trickles down into the bottom of the machine, to be run away later through the tap provided. When one side of the comb is emptied, it is reversed either automatically or by hand, and the other side is treated in a like manner.

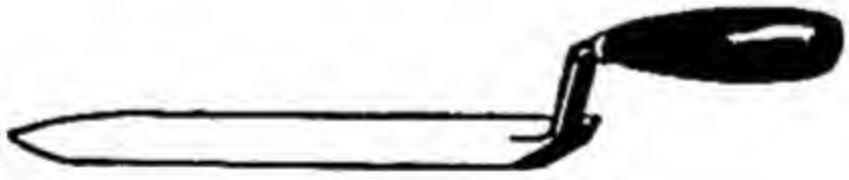
Emptied of its contents in this way, a comb becomes a valuable capital asset, its life extending over many years. The author is still using shallow combs brought south over ten years ago, and they

are still as good as ever. This, of course, goes to the credit of the extractor.

In using the machine, experience finds one certain speed—neither quicker nor slower—at which the honey flies best. In using new combs for the first time, some extra care is well worth while, as they throw out from the centre rather easily and crack across. This, by and by, forms a good plea for careful wiring. The bees will soon put them to rights again, but they should be levelled carefully before storing away. Extracting combs are better for having had one or two batches of brood reared in them, as they are considerably toughened by the lining film of silk the developed nymph leaves behind her in each cell.

Uncapping

This is best done with a specially designed knife. There are several types of this, the "Bingham," perhaps, being the best known.



The "Bingham" knife.

This knife has a heavy, wide blade with the edges bevelled and ground to a keen edge, which should be constantly maintained. If there are many combs to uncap, a pair of these knives is a great convenience. In service, they are kept heated in a deep pan of boiling water set over a

gas or oil stove, and are changed alternately as they lose heat and begin to pull.

For the man with a big apiary, a luxury is provided in the shape of a hollow, steam-heated knife which works by a tube from a small boiler, the used steam escaping from a hole in the tip of the knife. Doubtless this takes some of the drudgery off a tedious job. Probably some day before long, the knife will be heated by electricity, which will be more handy.

In uncapping, the lower end of the frame is rested on something solid. The comb is tilted slightly towards the knife so that the cappings fall clear as they are cut off. The cut is mostly started at the bottom of the comb and, with a sawing motion, is taken upwards so that (with practice) the cappings fall away in a thin sheet into some receptacle where they may be allowed to drain.

If there is much uncapping to do, it is worth while rigging up a tank of some kind for the job. An old-fashioned lard bucket does very well. A nail is driven into the rim and filed to a point so that a $\frac{1}{4}$-inch spike stands upwards to rest the comb on without slipping. A thin wood bar may be nailed on the opposite side to scrape the knife clear of wax and honey as needed. A hole bored towards the bottom of the bucket and fitted with a tap or peg allows the honey to be drained away. If a sieve made of a piece of expanded metal lathing or fine mesh wire is fitted about half-way down the bucket, the cappings will soon drain dry and be ready for rendering down.

The Ripener

It is, or should be, the desire of every bee-man to prepare his produce to the best advantage. As honey is thrown from the comb, it is filled with minute globules of air, particles of wax, grains of pollen, and other attendants of bee-life. If the honey was properly fit for extracting, it will take

The honey ripener.

a long time for these impurities to rise naturally through its density to the surface. To expedite matters, and for the sake of convenience, the "honey ripener and bottling can" was designed. This, as shown by the illustration, is a tall, narrow, galvanized iron receptacle made in two parts and fitted with a lid. The top part is in the nature of a sieve, being fitted with a fine perforated

strainer around which, for finer effects, is tied a thickness of cheese cloth. The bottom part of the receptacle is made in various sizes to hold different quantities of honey:

24″ × 9″ holds 56 lb. of honey
29″ × 10″ holds 112 lb. of honey
36″ × 12″ holds 150 lb. of honey

After the honey is extracted, it is run through the strainer into the ripener. In passing through the sieve it is cleared thoroughly of all foreign substances.

By allowing it to stand in a warm place for a few hours, all the air globules come to the top, and the ripening process continues in which, by gravity, the heavier grades sink to the bottom, and the thinner come to the top.

Excellent results may be obtained by standing the ripener in a copper of water heated until the finger cannot remain in it for comfort longer than half a minute. If the ripener is kept in this for ten to fifteen minutes—taking care that the water does not boil, or the aroma will be spoiled!—it greatly enhances its appearance. If the bottles are well warmed and the lids screwed down immediately after filling in the hot honey, this appears to retard granulation for a considerable time, besides rendering the contents bright and sparkling.

For convenience and utility, the ripener is certainly worth the 22s. 6d. to 33s. at which it is listed. With care it will last a lifetime.

Incidentally, it makes a first-rate uncapping can if a strip of wood is fitted over the strainer to rest the comb on.

Cleaning up Combs after Extracting

Unless it is desired to return the extracted combs to the hive for refilling, they should be cleaned up by the bees before storing away for the winter. Wet combs, unless subject to a continuous current of air, become mouldy and unfit for further use in " self-respecting " hives.

If there is abundance of room in the apiary, the wet combs may be stacked up at a convenient distance well out of the line of domestic traffic, and they will soon be fit for storing away.

But—only the experienced bee-man should attempt this! It is liable to cause considerable upset amongst the hives, particularly if the flow from the fields is slackening. It can be done, and is done regularly, but it is not always wise. When the combs are cleaned, the weaker hives (if such are tolerated in an up-to-date apiary) may be entered. Once organized robbing is started, hell is let loose for a bit!

The Super Clearer

Much the better and safer way is to put a super clearer on a strong hive, pile up several bodies of wet combs above this, with the cover on, and then towards dusk draw the slide which puts into operation the aperture shown on the plate. By morning the combs will be pretty well dry. The

slide is then closed, and the bees find their way through the escape into the lower part of the hive. The combs may then be removed at leisure and stored away in a dry place.

Storing Combs for Winter

Never having been overburdened with room, the author for years has piled all his spare bodies of combs on ventilated bee-tight stands in the garden amongst the hives, and has kept them there through the winter. The frost gets in; a few earwigs find a welcome shelter; but the combs emerge in spring as good as ever, wholesome, sweet, and free from mould.

VIII

THE PRODUCTION OF COMB HONEY

PROBABLY the greatest test of the bee-man's skill is the production of good, clean, well-filled sections in paying quantities.

This is not usually a self-evident proposition to the beginner. He sees stacks of the dainty, white-capped squares in the dairyman's shop window, and, finding from the bee appliance dealer's catalogue that less apparatus is needed for sections than for extracted honey, it becomes his ambition to harvest his produce in this form.

A year's experience teaches him that there is rather more attached to the problem than just that, however. He probably finds it is much easier to get a good run of swarms and casts than a full rack of sections any time; and if he is of a not easily discouraged nature, he presently puts his thinking cap on and discovers things.

The truth is that the expert is as much dependent on the geographical position of his apiary and climatic conditions as he is on what he knows about bees. Admittedly he will do better than a novice in any district, but if he is out to make his hives

pay, he has to work and plan for the crop that is most profitably harvested.

Why should sections be more difficult to produce than extracted honey?

For one thing, bees have a rooted objection to being divided up into working squads when their natural habit is to mass together in regiments. The prison-like cave of the section, entered by a narrow slot and hampered by separators, is so objectionable under normal conditions that, in the words of Cowan, "bees will often swarm rather than enter them."

This is most noticeable in a district where honey-flows are long and light; but in a region of clover, sainfoin, or heather stretches, where the flow is short and heavy, where the nectar comes in so fast that the bees tumble over one another with excitement, the objection vanishes. Once work in the racks is started, it goes on without a hitch, and sections are drawn and finished to perfection.

But even under those ideal natural conditions, the bee-man has his part to play.

Conditions for Success

For success in marketing, sections must be drawn out full and level, filled quickly, and evenly capped. And it is only by the use of stocks built up or manipulated to the highest state of efficiency and strength ahead of the flow that comb honey can be produced more profitably than extracted honey. The hive must be packed with contented, industrious bees working with a young queen, and conditions

so ordered that swarming does not enter into the question.

Swarming must be Avoided!

It is entirely on this contingency that successful section production depends, granted the necessary conditions of pasturage and climate.

It has been shown how, when working for extracted honey, swarming may be controlled so effectively that it becomes negligible. The principle is the same when working for sections. In this case, however, it is emphatically more important, as it is only by the use and continuance of a crowded hive that the latter is made at all possible.

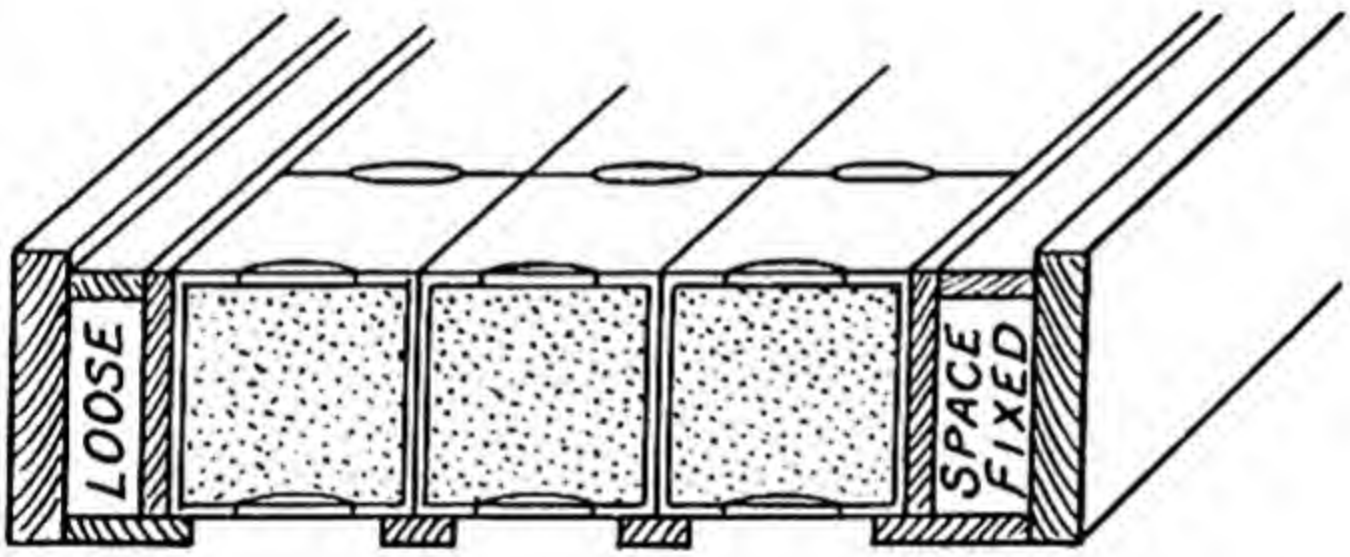
The Section Rack—Construction

The type of rack mostly seen with the " W.B.C." or similar hive, is not adapted for use in the manipulations necessary for swarm control. It is not suitable for working in between brood bodies, and for this purpose a different style has been designed. A glance at the one illustrated (Plate) will explain the principle of what is required. It is cheapness and simplicity itself to make, and in use it has few faults.

The outer walls are of $\frac{3}{4}$-inch by 5-inch deal ($4\frac{7}{8}$-inch finish) made the exact size of the hive body. The sections rest on $\frac{3}{8}$-inch (finish) by $1\frac{1}{4}$-inch cross pieces let into the ends of the rack as shown, and running from back to front of the hive when on. The side walls are formed in such a way as to enclose a space for insulation purposes which comes

over the ends of the brood-combs below. One side is fixed, but the other consists of a loose board $4\frac{1}{4}$ inches high, which, when the twenty-four sections are in place, slips in, and is held in position by a spacing strip at each end and a cover piece above (see sectional drawing).

To remove the sections, the loose cover piece is lifted with a tool, the spacers are taken out, and the side board comes away leaving the sections free for removal.



Sectional drawing.

At the front or back is a loose "dummy board" of a thickness suitable for use with or without separators.

The rack is easy to make and easy to use, and it affords the good insulation which is so necessary to conserve the heat the bees delight to work in. The $\frac{1}{4}$-inch bee-space is above the sections, as it is in the other bodies.

Separators and Sections

In recent years the introduction of American methods has worked something of a revolution in

the fashions of our sections. Along with the one-time all-popular 4¼ inches by 4¼ inches 4-way section, it is now possible to obtain "no-way," 2-way, 4-way, split, plain, and grooved, 5 inches by 4 inches, 1½ lb., and 2 lb. In separators one may get wood, tinned iron, and aluminium, slotted or plain, each with its particular use or fancy.

While specialists in comb production appear to vary their selection amongst the above mentioned, the ordinary man still seems to favour the old-style 4¼-inch 2 or 4-bee-way; and as the consumer does not find fault with it, probably it will remain in fashion for a long time yet.

If this is used during a rapid and heavy honey-flow, it is possible to dispense with separators, and thereby to obtain a quicker and readier response from the bees. There will be a proportion of lower grade finished sections, perhaps, but on the whole, results are better. In any case, it is worth experimenting with in order to gain a knowledge of the resources of one's district.

In the author's neighbourhood—a poor section place at best—an experiment was made by cutting separators out of perforated zinc, and certainly this showed an improvement on the ordinary slotted sheet metal one. The bees took to the sections more readily and did better work. Probably the little wooden prisons felt less cell-like with perforated than with solid partitions.

The "no-way" (plain) section used with the American wooden fence produces with the author good results in a light flow.

Experiments along different lines will soon prove the possibilities of a district, and it is useless to dogmatize in the absence of this knowledge. Perfect sections can be produced in any style. It is the country and the manipulations that alone can make them worth while to produce or otherwise.

The principle of the section rack described remains the same, but its height must be made relative to the height of the section chosen for use.

Preparing the Rack

The modern section is a beautiful piece of most exact workmanship; and if, in putting together, it does not almost do the work itself, there is something wrong in the method of the operator. After spoiling a few, however, the novice soon "finds his feet," as it were, and marvels that he has not "seen it before."

As received from the dealer, the wood is bone dry and practically hanging together at the cut-out corner V-joints by a few brittle fibres. Before attempting to bend them to shape, they should be stood edgeways on the table with a fairly damp cloth laid over them for a few hours; or alternatively (to save time) with a brush and a cup of hot water, go over each section *on the outside of the V-joint*, and then let it rest for a few minutes for the water to sink in. Do not touch the *inside* cut-out portion of the V-joint, or it may be difficult to fold square afterwards if it swells too much.

For the operation of folding the section and

inserting the wax it is a saving of time and money to invest in (or to make, which is easy enough) one of the special blocks supplied for the job. The dealers' lists mostly show them for about 1s. 6d.

To Make Folding Block for Sections

If you would *rather* be independent, get a piece of wood (any thickness) about 6 inches square, and another piece *exactly* 1 inch thick by 4 inches square, and screw the smaller one firmly on the face of the larger and in the centre of it. That is all there is about a folding block. Now cut another piece 4 inches square, any thickness, to hold the wax in place while it is being fixed in the section.

Having damped your sections, bend one around the fixed 4-inch piece, leaving the proper half of the split top standing up, and press the dove-tail locks into place. The section is now perfectly square. The loose 4-inch square may be used as a template to cut your wax foundation by.

Lay a square of the wax on the inside piece (which just comes level with the split) and push it up so that it just covers the bevelled cut. Hold the wax firmly with the loose piece of wood and double down the upstanding half of the top and lock it into place. The idea is to see that the section is folded dead square, and that the wax when put in and gripped in the split top will not buckle when tightened up in the rack.

Be sure when putting the wax in that it is right side up. This is accomplished by making the line

of the cells run parallel with the top, or, alternatively, to see that the sides of the individual cells are *vertical*.

It is no saving to use half sheets or starters, as this only leads in the majority of cases to imperfectly finished sections, sometimes left with half an inch space at the bottom.

In this connection, the author has found it pays to brush over the inner bottom side of the section with clean boiling wax after making it up. It practically ensures the wax being drawn and fastened evenly at the bottom.

Working for Sections

As it is more essential to have crowded hives when working for comb than for extracted honey, there is some amount of selection necessary in choosing each stock for this purpose. A lot of disappointment is occasioned by putting section racks haphazard on any stock that may be thought to be needing a super at a given time. It is well, therefore, in the early part of the season to decide this point thoughtfully, and then to proceed on the lines of crowding the chosen hives in early May as they would be normally in June.

It has been found desirable by well-known experts to employ one stock to collect and another to cap the sections. Every producer of comb honey will have noticed the difference that exists in the same apiary in the capacity to give comb honey that pearly whiteness of capping which is so much the charm and beauty of well-finished sections.

The Gist of the Matter

The idea is, by working on an early light honey-flow at full strength in a super of ordinary combs, so to have cultivated the "upstairs habit" that, when the proper weather and conditions duly arrive, the extracting super can be exchanged readily for the section racks without throwing the bees "out of their stride."

The chief thought all through must be to avoid swarming, and yet to attain and preserve intact that crowded aggregate under which, normally, swarming takes place.

How it Works Out (the Author's Practice)

If the stock has worked well in one brood body of ten frames, it must be stimulated early by gentle feeding so as to get it crowded well ahead of the main honey-flow. As soon as this becomes apparent and room for expansion is needed, the stock is "Demareed" by putting the queen with a couple of frames of brood into the centre of an extra body of drawn comb or wired foundation, and placing this underneath the old brood-box with an excluder to keep the queen in the nursery. She has now heaps of room to lay in, and will go ahead filling the new combs with brood.

Alternatively, the ten brood-combs may be divided as described in an earlier place (page 140), but using the excluder to keep the queen below. It works out about the same in the long run.

Manipulating for Brood

Continuing gentle stimulation, the queen is kept

busy by periodically lifting the youngest brood or eggs over the excluder, and putting down to her domain the oldest hatching brood-combs or those with empty cells. In this way the population will be steadily increasing; the young nurse bees will be kept upstairs out of the way attending to the developing brood, and no desire to swarm will manifest itself.

As soon as the first light flow begins in any quantity, feeding is stopped. A super of deep brood frames is put on over the excluder for storage purposes, and the other body lifted above that.

Queen Cells

The young bees in the top storey, being so far separated from the queen, will now prepare queen cells, and this is to be encouraged. But in the continued periodical shifts of brood-combs, every care must be taken to ensure that no incipient cell is taken below or all the good will be undone.

The Excluder Screen

The excluder screen (previously described) is now brought into use. The escape is closed, and the panel is opened so that limited movement is allowed between the attic and the first and ground floors *via* the back combs.

The queen cells are limited to three (all on one comb, if possible), and while the queen grub is being fed, the bottle is replaced and a good allowance of syrup can be given with profit. The three cells are later reduced to one—the best shaped

and the likeliest looking—and in due course this hatches out. The side flight hole is opened; the young queen eventually takes her marriage flight and (let us hope) returns safely to her important duties.

The Main Flow

By this time the clover will be creaming the meadows and road-sides in force, and it is time to throw all the weight of production into the section racks. To this end certain preparations are necessary within the hive in order to direct the energies of the bees into the right channel and to keep them there.

Changing Queens

It is an old, almost axiomatic truth that " when a young queen is reared by the colony itself, swarming rarely occurs the same season " (Phillips), and this idea may now be exploited for the benefit of the section racks.

As a preliminary, the wings of the young queen are clipped and she is returned to the comb she was on, which is then put into a nucleus hive for a short time until the hive is rearranged.

The top brood body she was in is then lifted off and placed on a stand close by.

The middle storage super is next lifted away and covered up to await attention.

The old queen in the bottom storey is next removed, and either killed or slipped into a matchbox to be disposed of later. The combs are rapidly

gone through, and all eggs or very young brood are exchanged with older combs from what was the top storey until ten combs of old or hatching brood inhabit the bottom storey.

Two racks of sections (which have been prepared previously and which include as many as possible drawn out sections saved from last season) are placed on the hive, *no queen excluder being used now*.

The excluder screen is placed over the sections with escape closed, panel uncovered, and flight hole open. The top storey, now filled with the youngest brood and eggs, is lifted on to the excluder screen, the wood quilt put on it, and the whole surmounted by the deep roof.

The old storage super is now uncovered and the bees brushed or shaken from the frames on to the alighting board. As they run into the hive, the young queen is taken from the nucleus and placed gently in the thick of them and watched until she disappears into the interior.

The now beeless super is lastly given to an extracting hive for completion.

Results of the Manipulation

The young queen will take possession of the cells as the young bees hatch out, and will continue laying, deterred by custom from climbing into the sections.

The field bees, having nowhere to store in the bottom, will perforce take their loads into the supers.

The young nurse bees, all the while emerging below, will find their way up to the hatching eggs and young brood in the top storey, to which they will gain access *via* the excluder screen panel. As they become old enough for field duties, they will either go below through the panel or fly *via* the flight hole.

They can be utilized for rearing further queens, or the resultant cells can be destroyed.

If a queen is reared and fertilized, by a little care a new colony can be built up and removed later to a fresh location, to be strengthened by surplus combs of brood from other hives.

Lastly

As the field bees from two full hive bodies have been crowded into one body, such a strong force will naturally secure the utmost profit possible from the location and the weather, and will end the season rich in stores of honey and young bees headed by a vigorous queen.

Changing Position of Racks

As the bees will first commence to work in the super nearest the brood nest, it is necessary after a day or two to change their position so that both may be brought into equal use.

If, later, it becomes advisable to put on a fresh rack, this must be placed *under* the other two, next the brood nest. The upper rack should be removed as soon as it is finished to avoid undesirable " travel stain."

Alternatives

For his own location (a poor one mostly) the author has found the above to be the most profitable method; but in other districts it might not " pay out " so well. The practice and experience of others is therefore offered as alternative suggestions.

The Dolittle Method

This is the plan of the well-known American bee-man and author, tested over many years, and published in his works on bee-keeping.

At the beginning of the early flow (about May 20th in U.S.A.), when his hives would be strong in bees and brood, he placed an excluder on the brood nest, and above that a brood body with eight empty combs and two of stores.

About a month later, when the clover harvest was just coming into evidence and swarming might be expected, he lifted the brood nest off the stand and stood the storage super (now filled with the early honey) on the floorboard. He took out the centre comb and put in its place one from the old brood body on which the queen was found.

The section racks were now placed on the new brood-chamber, and the bees from the old one were shaken in front of and run into the hive.

As the queen needed room for laying, the combs were cleared of the honey which was carried up into the sections.

The old brood-combs were used to strengthen other hives, or formed into new colonies.

The plan produced good sections, but, by losing all its brood, the colony was weakened to that extent for wintering.

The Miller Plan

Dr. Miller was famous the world over for his success with bees and his writings on the subject. He held the world's record of average production per colony. In one season he produced forty dollars' worth (£8 6s. 8d.) of extracted honey from one hive.

His plan for section production is a similar one to Dolittle's, differing chiefly in the fact that he did not rob his hive of all its brood when supering.

He built up his stock to two bodies' strength, and one extracting super, if necessary, on the early flow. Then as the clover crop started, he selected from the twenty frames ten having the most brood to form his new brood nest. The queen was placed on the combs and the bees shaken off the other ten to join her; the latter being disposed of as in the other plan. Sufficient section racks were given and added to as required.

Conclusions

The germ of success in the production of sections lies hidden in the three examples of practice detailed. As conditions vary so much with locality and geographical position, it is useless to say that any particular method is infallible. Each bee-man must study his own district possibilities and work out a system to meet it. But it may very

emphatically be said that the old way of placing haphazard, ill-contrived racks on weak or unprepared colonies stands condemned by its lack of success, and only a thorough understanding of the subject can produce satisfactory average returns through the varying conditions of the English climate.

Unfinished Sections

Whatever system of comb honey production is followed, there inevitably comes the time when the honey-flow begins to wane, and one faces the probability of being left with an indefinite number of unfinished sections on hand. A certain quantity is all to the good for use as " bait sections " in the next season. But if present profit is considered, a little manœuvring now is desirable.

Immediately the tide begins to turn, the racks should be inspected and all finished sections should be removed; one rack for each hive being made up of the unfinished ones. The whole strength of the foragers is now crowded on them.

If extracting has left one with any quantity of thin or unripe honey below the normal standard of specific gravity, this should be fed to the section-filling bees in quick feeders, and by this means many sections will be rendered marketable. It is a perfectly justifiable procedure, and certainly more profitable than trying to ripen the honey artificially. But it must be *honey* that is fed back; not sugar syrup. The cleverest alchemy of the bee is not potent enough to transform the latter into the

former, and it would be rank dishonesty and unworthy of a real bee-man to try the experiment for sale to the public!

Taking off the Racks

In working for extracted honey it is immaterial whether the capping is perfect or not; but in sections, a good finish is a necessity for competitive sale or storage.

In the former case, it is a common practice, after smoking the bees into subjection, to remove the combs singly or otherwise as they become available, brushing the bees off them into the hive. In sections, however, this is not a good method to adopt.

It has been explained previously that as soon as a bee is thoroughly alarmed, its first impulse is to run to the nearest honey and "drown its fear in drink." If there is no open cell, it may puncture or tear off the cappings in its excitement.

It is therefore imperative, if perfect sections are desired, to use a "super clearer" when removing sections from the hive.

IX

WAXCRAFT

WHAT to do, and how best to do it, with all the odds and ends of wax that accumulate in even the smallest apiary, is a question that worries the *little* man no end. The *big* man has solved his problem in the transition stage by adding to his capital expenditure when he found it impossible to temporize any longer as his hives multiplied.

Without proper appliances (which cost money!) the rendering by domestic methods of wax cappings, old combs, scrapings of sections, brace combs, and suchlike into a form that can be classified as "worth so much," is a nasty, messy, unsatisfactory job to be put off as long as possible and then scamped, to the loss of half its value usually.

The Press

It is generally agreed that for the utmost particle of wax to be recovered from the residue, there is only the final resort of mechanical pressure added to heat. This is applied on the principle of the Archimedean screw, and as the power of this is enormous, everything with it must be of a great strength. This, of course, means high costs, and so it is only the really big man with his hundreds of

hives who can treat his wax by this method. The professional bee-man in the Colonies and the States appears to fit himself up with this in preference to other apparatus.

The Steam Extractor

For the rest, the dealers offer a variety of wax

extractors which, in one way or another, act by the application of steam on the wax.

The apparatus consists of two parts: a lower pan which holds water, and an upper one in which there is a perforated metal basket to contain the wax. The apparatus is set over heat (a stove or Primus burner) and the resulting steam passes through the basket, melts the wax, which falls on a tray, and so

to the outside by way of a spout. The price of this varies from about 18s. to 27s. according to size.

The Solar Extractor and its Construction

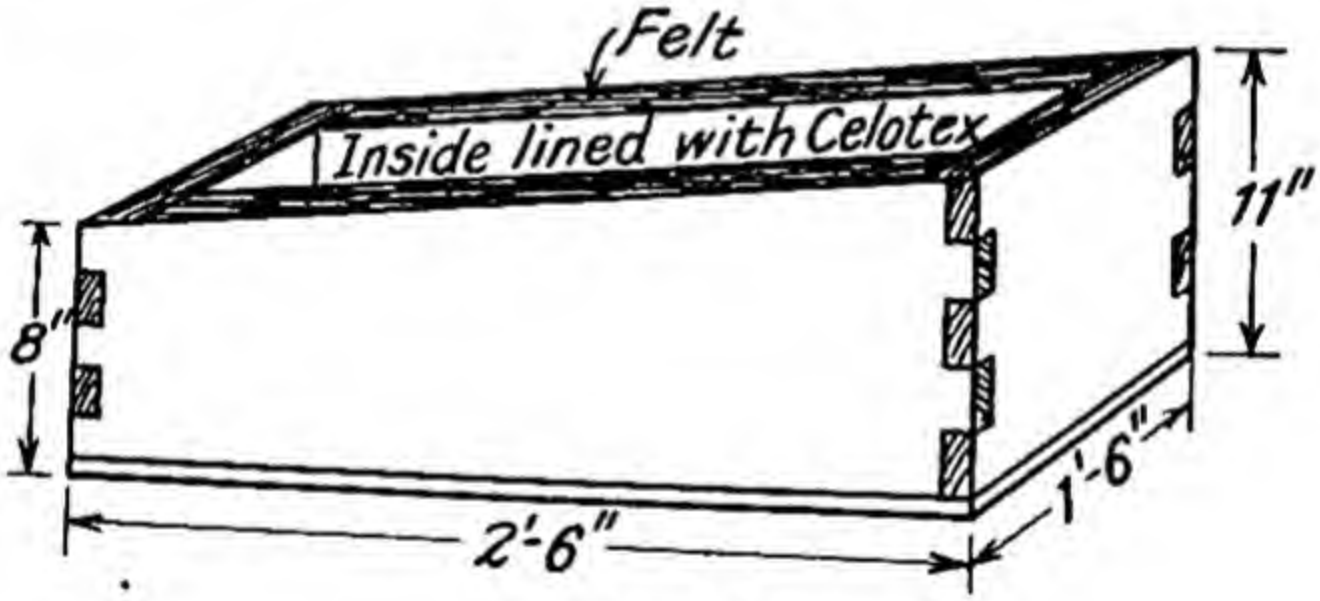
While this is probably as far short of perfection as the rest, the author finds it to answer all his own purposes with absolutely no labour, no running cost, no inconvenience, and little outlay in the making. Set in a convenient corner of the garden, it is always available, handy, unobtrusive, and at work from morning to night without any attention so long as the sun shines. It produces clean blocks of the purest wax, preserves the aroma, and bleaches the product to a natural colour.

Being kept close to the hives, there is always the incentive to pick up and save every scrap of wax that arises during manipulations. This is good for the morale of the apiary, and better for the profits that accrue. Beeswax is, for its bulk, by far the most valuable product of the bee, and it pays to save every particle for melting down.

The working principle of the Solar Extractor is that by being painted *black*, all heat that falls on it is retained—absorbed without reflection or radiation. The double glass with its enclosed space allows the sun's heat rays to enter and collect, but the partial vacuum prevents its easy escape, on the principle of the double walls of the "vacuum flask." As the heat rises, the narrow expansion hole bored through the bottom rail acts as a safety valve without much practical loss of efficiency.

The attached drawings represent an extractor which has been working in the author's apiary for several years at a running cost of nothing beyond a yearly coat of black bitumen varnish, put on in the autumn before storing away. It has certainly paid for its making many times over by turning worthless combs and previously unconsidered scraps into cleanest block wax. A very Autolycus, it is!

The total cost of the materials was between 14s. and 15s., and it was made as a recreation for a wet day. Its finish is probably amateurish, but its value is professional.

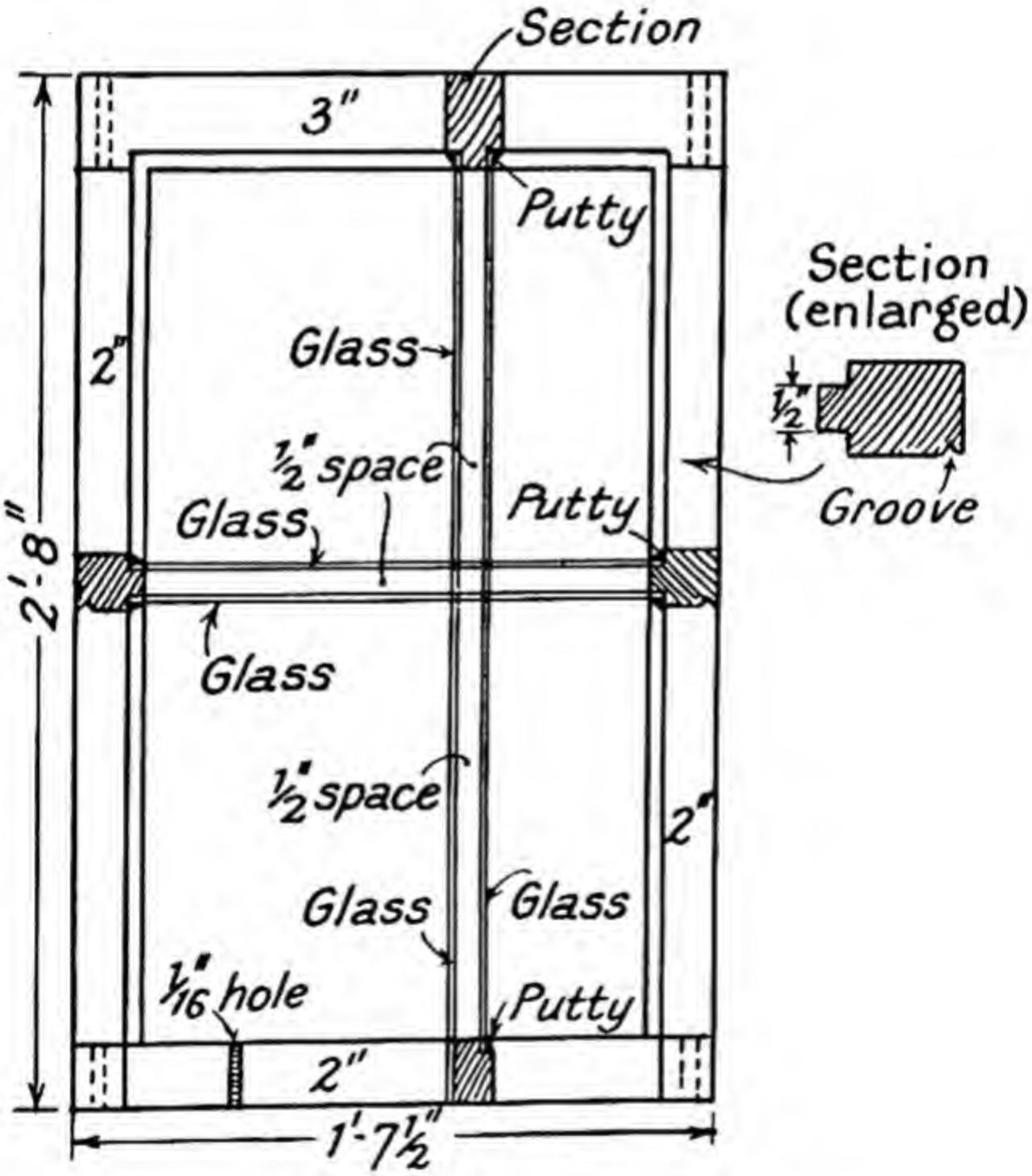


(Fig. 1.)

The body box is made of $\frac{3}{4}$-inch by 11-inch planed yellow deal ($\frac{5}{8}$-inch finish) to the dimensions shown in Fig. 1. The ends are roughly dove-tailed together and nailed. The inside is lined with Celotex, closely jointed and carefully nailed to the wood sides. The bottom is of $\frac{1}{2}$-inch rough deal.

The slopes were cut off the 11-inch width, and the resulting 3-inch wedge pieces kept to make the sides of Fig. 3. After being satisfied that the slopes

and ends were levelled off perfectly to make a close joint with the lid, a strip of billiard cloth was glued on all round to make the joint air-tight. Thin felt could be used just as well. The point is to make a perfect contact all round with the lid to prevent escape of heat.



(Fig. 2.)

The lid (Fig. 2) is fully detailed in the drawing. The top rail (hingeing piece) is of 3 inches, while the rest are 2 inches wide by $1\frac{1}{2}$ inches thick (finished).

As the principle of the apparatus rests in the

double glazing of the lid for the conservation of heat, it will be understood from the sectional drawings shown that the top rail and the two sides are double rebated on the inside edge ½ inch by ½ inch, which leaves a ½-inch centre to keep that space between the glass panes when glazed.

All round the outer edge a water grooving is made to prevent rain getting into the felt joint.

The bottom bar is rebated underneath, but cut away on the upper side to allow the top sheet of glass to come well down the wood to throw off the rain, as in the garden light.

Made by a professional joiner, it is probable the frame would have been grooved (and not rebated) for the glass. It was found easier, however, for an amateur to rebate the frame as shown, the glass (21-oz. sheet) being afterwards bedded on putty, pinned in with panel pins, and top puttied afterwards. It will certainly be easier to replace a breakage of glass when rebated in. The angles of the frame were mortised and tenoned together as shown.

Before glazing, the rebates were given a coat of dead black paint so that there would be no bare wood between the glass to prevent full absorption of heat.

A 1/16th-inch hole was drilled through the bottom rail (as shown) to allow for expansion of the air between the double glazing, otherwise the joints would have " blown " in the full heat of the noonday sun.

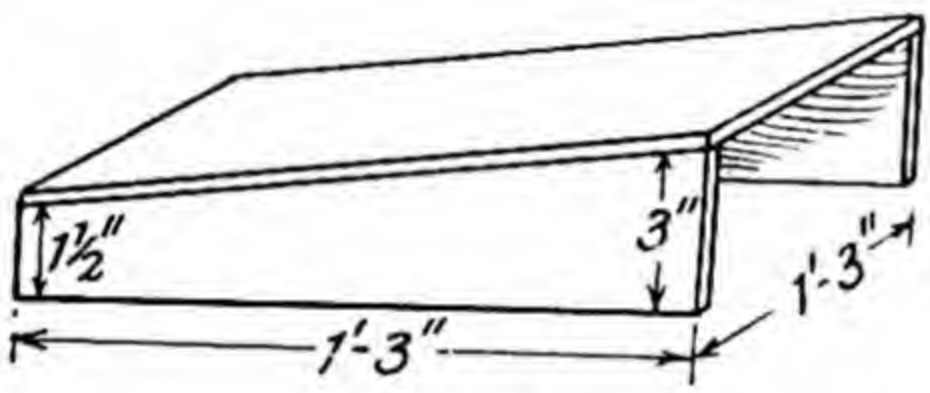
It will have been noticed that the lid is allowed

a good overhang all round to throw rain and condensation clear of the body box. This is to be borne in mind when fitting the box hinges. The lid is completed with a "universal" fastener at the bottom, which may be padlocked if desired.

The interior furniture is shown in Figs. 3 and 4.

The tray in the original is made of sheet zinc somewhat amateurly bent and soldered together, but a better article would be made of tinned sheet by a professional tinsmith.

The important point of the tray is the provision



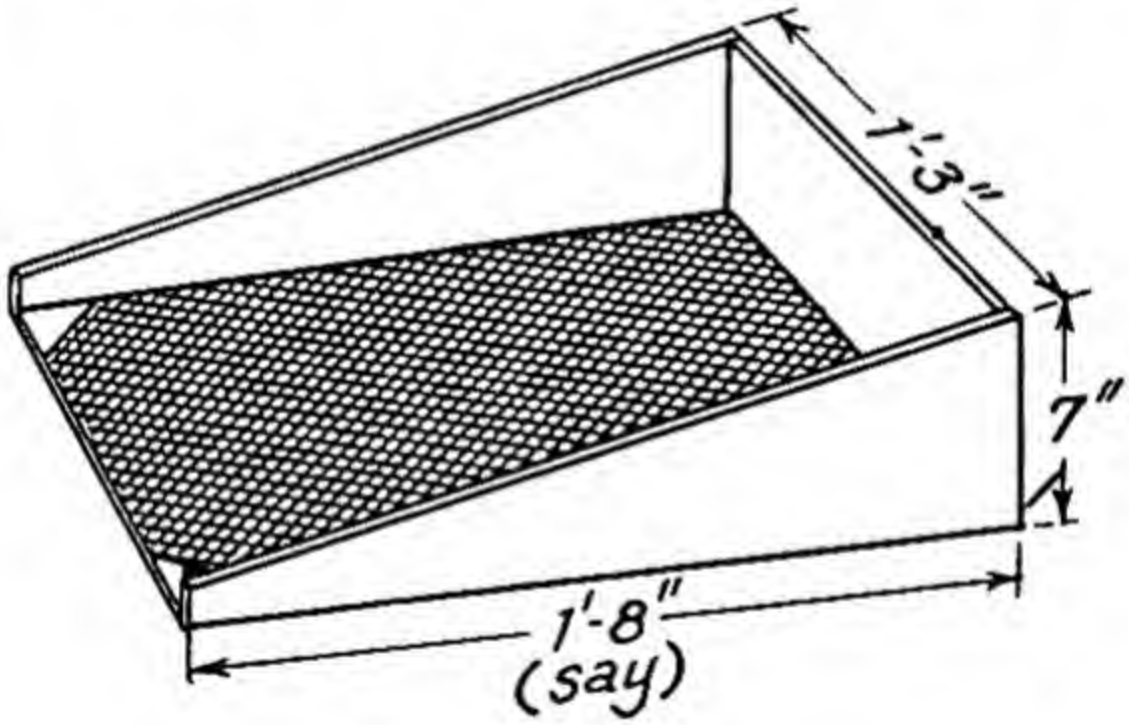
(Fig. 3.)

of a grid of expanded metal lathing which is bent round its edges to form a rim to keep it about half an inch above the floor of the tray. As the wax melts, it drips through the grid, and falling on the bottom of the tray, runs down its inclined surface into a shallow receptacle placed to catch it on the floor of the body box.

In the author's extractor, a 12-inch by 8-inch by 1¼-inch photographer's enamelled "fixing bath" does duty for the wax receptacle, but a utensil more in keeping with the "solemn fitness of things" could doubtless be found if desired, although it would not act a bit better.

In use it will be found that all the "dross" remains on the metal grid, while the clean wax finds its way into the appointed place. Periodically, the grid can be put on a red fire and burned clean without injury. If the receptacle is rubbed before use with medicinal paraffin, the wax cake will turn out easily when desired.

If a stand of some kind (three or four bricks will do) is arranged for the extractor to sit on in the garden, it will prevent it being attacked by decay



(Fig. 4.)

and will make it last a lifetime. It is better to put it under shelter for the winter.

The Solar Extractor is listed in the dealers' catalogues at 28s. to 32s.—built on a somewhat different principle, but probably as efficient in general use as the one described.

The average bee-keeper is a handy man, and probably finds an outlet for his energy in devising and making his own apparatus. It is for this reason

that details of construction are given and not with a view to competition.

For disposing of small quantities of wax, the man with few hives will doubtless find it convenient to accept the offer of the dealers to take his product as part payment in the purchase of necessities. The man with a large turnover, however, will devise his sales as his experience has taught him, far better, indeed, than the author can advise.

Side Tracks and Contingencies

We have now traversed at some length the main line connecting the expanding flower with the delicious, white-capped section or the jar of whole-some honey.

To complete the survey, there yet remains for us to explore, however briefly, some of the side tracks which at various points may—and most often do—deviate from the normal in unexpected or undesir-able directions.

X

THE BEE IN DISEASE

It was recalled in a previous section (page 26) how, when the "Isle of Wight Disease"—as it was called for want of something worse—was ravaging the country from south to north, leaving a trail of dead and dying in its path, bee-keepers of all grades of intelligence were utterly ignorant of its cause, and totally unable to deal effectively with the scourge on that account.

We know now, thanks primarily to Dr. Rennie, that the trouble arises from the infestation of the breathing tubes in the thorax by a member of the Natural Group known to Science as the *Arthropoda* (jointed footed), which includes the two important classes *Insecta* (possessing antennæ, compound eyes, and three pairs of walking legs) and *Arachnida* (without antennæ or compound eyes, and with four pairs of legs), to which the bee and its parasite respectively belong.

Before 1920, our main (and only definite) knowledge of the progress of the disease was recognized by that condition of the bees known as "crawling."

As they came from the hive they made a futile attempt to fly, which, failing, brought them to the ground, where they crawled up and down in increasing numbers until their death.

We know now, however, that under the old designation of the "Isle of Wight Disease," with its symptomatic "crawling," several maladies were grouped, two of which, probably, interest the average bee-keeper most nearly—the acarine infestation and the nosema disease.

In each case a true diagnosis can only be carried out by the use of the microscope in one form or another. The method is simple, however, and with due attention to details, it is not beyond the ability of any normal person to identify the acarine infestation, whatever may be the difficulties in the case of the others.

Once the principle is grasped, and the mind is rid of the childish idea that "only a very scientific fellow can dissect," the average bee-man with decent eyesight, a fairly powerful magnifier, a pair of fine scissors, a couple of needles stuck in pen-holders, and some ingenuity, can "bring the varmint to judgment" as surely as a college professor.

When this is realized, many a devoted bee-man whose heart has ached as he has seen dead bees gathering about the front of his hive, will be relieved to find that what he took to be "the disease" was merely the periodical sweeping up of the floorboard because the sun shone.

In the early months of the year, the author was

asked to examine and report on eight lots of suspected "Isle of Wight Disease" from various parts of the country, and in not one case was there any reason to blame the "mite." In the main they were dried up old bees which had died from natural causes; one or two were certainly due to lack of food; one as surely to nosema disease, and the rest apparently the result of unsuitable food having caused dysentery.

For this reason, it is desired to make the diagnosis plain to every man who loves his bees and who feels sorry enough to do something when they are unhealthy.

Method of Dissection for "Mites": Diagnosis

As shown on page 28, Spiracle I, the opening of the main thoracic trachea in which acarine infestation occurs, is situated just in front of the root of the forewing, and extends immediately under the horny casing of the thorax forward to the head.

A bee may be picked up by the wings between the first finger and thumb and its head and legs snipped off. With fine-pointed scissors, press one side into the neck opening and make a snip up to the top centre of the thorax. Now from that point clip off a slice of each side of the thorax in front of the wing root, and you will have got the two main tracheæ in which the trouble lies.

On a piece of clean glass put a drop of *salted* water and immerse the two clippings in it.

Now on a table near the window put a sheet of white paper to reflect the light upwards; on it place a thick book and insert your square of glass between the pages. By a bit of ingenuity and patience your magnifying lens may be fixed up to focus on the drop of water (see Plate opposite), or if it is in the form of a watchmaker's eyeglass, it can be monocled.

Holding the clipping steadily with one needle, with the other gently scrape aside the stringy muscle stuff inside the shell, and beneath it you will find a tube having the general appearance of that ringed pipe which Nature arranged so obligingly for the butcher man to hang up a cow's internal economy by.

One end of the tube will be fast to a split portion of the horny shell of the thorax (the spiracle), the other will be just as much or as little as you will get by judicious management. That is immaterial, however, for the purpose; infestation first starts from the spiracle end.

If the tube is of a pearly white, the bee is almost definitely clear of acarine infestation. If it shows brown (light to dark) patches, you may be equally sure it has got it—these patches being the result of blood diffusion where the mite has pierced the tracheal walls of the tube to suck the blood.

In the latter case, if you now remove the bit of tube by scraping it clear of its anchorage (the pro-thoracic flap or the anterior edge of the mesopleurum), put it tenderly on a clean place of the glass, and hold it up to the light, you may

probably see with your magnifier little indistinct, spidery shadows within the tube. With your fine needle point lacerate the tube, and in a moment or two a tiny creature may come out and wander around, manifestly too surprised for words at the outrage.

That is all you can see with a simple x10 magnifier. But you have proved your point.

Under the magnification of a $\frac{2}{3}$-inch or $\frac{1}{2}$-inch objective, say from 70 to 100 diameters, a compound microscope will reveal more detail but no more certainty.

Method of Dissection for Nosema Disease: Diagnosis

If, in the suspected bee, the respiratory tubes of the thorax do not reveal anything abnormal, attention passes to the abdominal regions, where reside the digestive organs.

But now the diagnosis passes beyond the simple magnifying glass stage, which even natural in- nuity cannot very well make up for. Nowadays, however, the possession of a compound microscope is not beyond the means of the average man, and as a practical educator, it is worth a fortune in miscellaneous reading matter.

But in the intricacies of bacterial diagnosis and identification, neither the possession of a compound microscope of the highest excellence nor the manual dexterity to use it successfully will alone give anything approaching certainty. Even the trained bacteriologist feels dubious under certain conditions.

If " crawlers " are found issuing to any extent from a hive, and dissection of several bees does not reveal the presence of *Acarapis woodi*, it is pretty certain the stock is affected by what is known as nosema disease. This symptom is practically all the average bee-keeper has to work on in the way of diagnosis. His bees are " crawling " and dying in numbers above the average: that is all he can see.

If the abdomen of one of these bees is opened, either by pinning it down on a wax bed and carefully cutting away with scissors or scalpel the horny rings, or by pulling the organ to pieces with forceps or tweezers, it is possible by a bit of careful handling to remove the stomach separately without having burst the loaded colon. If now this organ is put on a glass slip or a live box with a drop of water and teased out with a couple of needles, then pressed beneath a cover glass and put on the microscope stage under a $\frac{1}{2}$-inch or $\frac{1}{4}$-inch objective, there will most likely be seen innumerable oval organisms floating around and issuing from the shredded stomach.

These organisms, if the spores of *Nosema apis*, are described by Miss Betts (*Practical Bee Anatomy*), quoting from Zander, the discoverer, as " highly refractive, 4-6 × 2-4μ in size. Confirmatory signs are the presence of pale, watery fæces, the whitish naked eye appearance of the stomach, and the absence or scarcity of calcium carbonate granules in the stomach cells."

There is this curious fact about the organism,

by the by, it is certainly found in abundance in the stomach of a bee which has died of nosema disease, but it may also be found in almost similar abundance in bees which have no outward sign of disease.

When Zander, in 1909, published his discovery of the protozoon and named it *Nosema apis*, he apparently associated it from mainly circumstantial evidence with the death of many thousands of colonies annually.

In America, Dr. Phillips does not find from his experience sufficient evidence to label definitely the organism as the *cause* of disease, but he thinks it appears to indicate that it may be rather an "accessory before the fact." He finds it "occurs rarely except in colonies that are depleted from some other cause such as dysentery."

In England, on the other hand, Mr. Arthur G. Sturges, B.Sc., is emphatic that *Nosema apis* is a national danger "of vast importance." "In Switzerland and Germany," he says, "nosema disease has been described as the greatest disaster which has occurred to the craft. . . . A recent estimate of the loss incurred in Switzerland . . . places the sum at £40,000 annually."

The position is certainly serious enough to warrant careful thought and increasing scientific investigation.

Conflicting evidence in such high quarters would almost suggest to the lay mind that the nosema spore may be, perhaps, a concomitant rather than a direct cause of disease; but until scientific research

unites all authorities, Mr. Sturges' solemn warning should be our guide.

There appears to be no definite and all-embracing cure yet, other than by manipulative methods of working out or lessening the virulence of the disease.

Every bee-keeper can do his humble share by keeping his stocks strong at all times, and by re-queening only from those stocks that show vitality and the ability to work up to a high standard.

Remember that a really good queen can always produce bees quicker than disease kills, and all ailments can best be kept under by these means.

Treatment of the Acarine Infestation

Dr. Rennie's Treatment

In a description of the breathing system of the bee in an earlier section of this book (page 28), the process of acarine infestation was referred to at some length. Reference was then made to the discovery of the disease by the late Dr. Rennie, and his views on the subject were given.

Careful study of the mite revealed a life history of egg, six-legged larva, immature, unmated adult, and fertile adult of both sexes.

By an ingenious method of washing and centrifuging, Dr. Rennie satisfied himself of the great probability that the migration from bee to bee must be undertaken only by the fertilized female,

all the intervening processes of ovulation, birth, and marriage taking place within the bee's tracheæ.

Granting this, an explanation had next to be given how a creature of such lowly organization and sluggish life could find its way from the spiracle of one bee to that of another. It was incredible that the colonization could be conducted through conscious thought, and yet, how otherwise could so cunningly hidden a place be found so unerringly as the sequence of life demanded?

To meet this obvious difficulty, Dr. Rennie postulated the exhalation of a distinguishing odour from the spiracle which would act on the physical senses of the mite. This was quite in accordance with the theory of the bee's respiration *from* the abdominal spiracles *to* the thoracical.

The hypothesis fitted the facts so well that on the strength of it, Dr. Rennie devised a method of treatment based on the idea of " masking one odour with another." He suggested the plan of using the strongly aromatic methyl salicylate (oil of wintergreen) as a means of making the mite lose its way when migrating, and keeping it " wandering in the wilderness " so long that the " killing " mixture

Chloropicrin	1 part
Camphor	1 part
Methyl salicylate	12 parts

would be able to do the remainder of the work thoroughly.

Used by the present writer, Dr. Rennie's treatment acted perfectly in an outbreak he had in his apiary, but its efficiency has been strongly questioned by others.

Methyl salicylate was used constantly and unsparingly for several days on blotting-paper pads inside perforated zinc pushed through the winter entrance hole well under the frames, and the "killing" mixture was inserted with a pipette in doses of five drops each second day for a week, on to a pad laid on the tops of the frames beneath the sheet of glass in the *wood* quilt.

It is possible that the failures were due to the use of porous fabric quilts above the frames, with the consequent rapid dispersal and escape of the fumes. The wood quilt certainly conserves the heat and fumes.

The "Kasemol" Treatment

At a later date the author finally cleared his apiary of the last traces of the infestation by the experimental use of "Kasemol"—a proprietary "non-toxic local analgesic" described as a Japanese derivative of menthyl salicylate in combination with natural oil of camphor, menthol, and distilled aromatics. It is sold by all chemists.

This was used similarly to Dr. Rennie's mixture, in doses of six to anything like twelve to twenty drops each day on a pad placed on top of the frames under the glass-covered feed-hole of the wood quilt. The floor fumigant of methyl salicylate was used as before.

In ten days' time the last traces of the outbreak were gone and there has been no return of it.

The Frow Treatment

In the *British Bee-Keepers' Journal* of November 17th, 1927, an announcement was made by Mr. Frow, of Wickenby, giving particulars and details of a method he had discovered whereby the mite, *Acarapis woodi*, its larvæ, and eggs inside the tracheæ of the adult hive bee could be killed without detriment to the latter.

The prescription, which later accumulated experience has not seen fit to alter at all, was described as a mixture of

Safrol oil	1 part
Nitrobenzine	2 parts
Petrol	2 parts

The publication of what appeared to be an all sufficient treatment for a terrible scourge was received with the greatest interest by bee-keepers, and results of its use were published under the names of some of the best-known men connected with the pursuit.

Col. H. S. Howorth, C.M.S., of Bideford, who, as he states, had been a constant sufferer from the infestation of his hives for four years, took up the matter with great enthusiasm and fervour, and became the St. Paul of the movement, spreading the gospel far and wide.

In a series of articles published by the *B.B.J.* in its issues of June 7th, 14th, 21st, and 28th, 1928, Col. Howorth compiled an amazing sequence of facts and figures, as convincing in their completeness of detail and wideness of scope as ever came from the pen of a reformer. The whole fraternity of bee-keepers not only owes a debt of gratitude to Mr. Frow for having so magnificently given his experiences freely to the world, but also to Col. Howorth for his unsparing and successful efforts to broadcast the good news to all.

Briefly epitomized, the treatment may be stated as follows:

The most successful period for its use is between November 1st and February 1st (this being the time of the year when robbing is least to be anticipated).

The dose is one-half drachm (*exactly*) on seven consecutive days.

It is to be distributed on a large pad pushed well under the combs. The pad is to be as large as possible, coarse and hairy to help evaporation. It is to be finally removed on the tenth day.

The whole width of the hive opening is to be left free for ventilation, protected by a sheet of perforated zinc with a small space cut for flight purposes.

The quilts must be sound and, if possible, well propolized to retain the fumes above.

The floorboard must be scraped each day to remove dead or dying bees.

The mixture is poisonous and very inflammable; verb. sap.

The results appear to be certain, and as the treatment is now universally known, fullest details are easily obtainable from any up-to-date bee-keeper whereby the greatest advantage may be secured from this most remarkable discovery.

XI

ROBBING

THIS is a trouble of inexperience or carelessness—or both. It is the converse of "opportunity making the thief," and will turn an apiary of quiet, contented workers into an inferno of maddened desperadoes at a moment's notice almost.

More especially at a time when there is a dearth of nectar in the fields, the utmost care should be taken to avoid the exposure of honey or syrup about the hives. Every scrap of waste wax cappings or brace comb should be carefully put in the Solar Extractor or a covered vessel. If it is necessary to remove a partly filled comb from a hive, it should be placed at once in a hive body with a cloth over it. If it is necessary to shake the bees off it in front of a hive, any thin nectar that may be flung from it on the alighting board should have a handful of dry garden soil thrown on it to absorb it.

The entrance to each hive should be suited to the strength of the colony, and any badly fitting floorboard or crack in the hive should be carefully adjusted to keep out unauthorized callers.

If a hive is attacked, the entrance should be reduced to one-bee-space so that the defending guards can occupy it. If the attack is too strong for this, effective use can be made of a garden syringe and a bucket of cold water, or a watering-can, to wet the front of the hive thoroughly. A bee hates a chilly reception, and cold water soon damps its ardour.

A piece of glass leaned in front of the opening upsets the robbers' calculations, while the inhabitants soon learn to use the side passages.

Prevention is better than cure, however, and one or two attacks point this moral very efficiently.

XII

UNITING STOCKS

It has been shown in a previous section how success with bees depends in the main on keeping strong stocks. Under no condition is it economical to tolerate weak colonies either in the early season in the hope of building them up in time for the honey-flow, or later, from a fear of reducing the aggregate of the apiary.

If in spring it is found that some colonies are weak, it is far better and more profitable to unite them into a lumping stock, and then, later, if increase is desired, to rear a queen or queens by the methods described, and obtain contributions from other hives to build up a decent colony or colonies. Both surplus and increase can thus be assured, while neither would have been certain otherwise.

If at the end of the season a colony becomes queenless, it is almost invariably more profitable to unite it with another stock than to provide it with a queen at that season.

So long as there is nectar coming in from the fields, two stocks can be united easily by alternating the combs of one with the other. In the evening each stock is first well smoked, and the combs are

then parted so that no festoons of bees hang from one to the other. If now the combs are alternated and left just so far apart that they do not actually touch, they can be covered up and confidently left to unite, the combs being spaced normally next day.

Of course one queen only will be left with the stock, and if the survivor is on one of her own combs among her own bees, she is quite safe from attack.

There is no need to waste good flour on the operation as the old bee-men taught. It is only a nuisance afterwards and without present value.

It is best, in uniting two hives, to bring them together by degrees. Bees learn to locate their own hive by position, and any alteration must be done gradually, about a foot a day; otherwise the bees will still continue to follow their old flight-path and be lost, or united to another hive if it is put in the same situation. If at the end of the gradual movement one hive is placed midway between where the two last stood, the two colonies may be considerably aided if boards are sloped from the outer angle of the entrance each way for a day or two.

An easier way than handling the separate combs, is to uncover one hive, lay a sheet of newspaper across the frames, prick a hole or two in the paper with a lead pencil, then lift the other hive bodily on top of it, and cover up. If this is done in the late afternoon, the two stocks will be hard at work next day as if nothing had happened; and the newspaper will be brought out gradually in shreds and powdered fibre.

If, during a honey-flow, when all the bees are coming home laden with the spoil, one hive is taken away and a neighbouring hive is placed midway between the two old stands with a slanting board from each position up to the entrance, the two sets of field bees will use the common entrance and carry on their joint labours peaceably. In this case, it is well for the chosen queen to be caged for a day or two until everything is settled down again, or the strange bees might molest her.

Queenless stocks may be united direct without any preparation, and a fertile queen can be given to them later.

If it is desired to strengthen a colony by the addition of other bees, it may be well smoked towards evening, then the others to be added may be shaken on the entrance board and run in like hiving a swarm. If, when they are all in, another vigorous smoking is given and the entrance contracted to retain the smell, there is not likely to be any trouble in the uniting. The smoke will have masked the colony odour and given all the same smell.

XIII

INTRODUCTION OF QUEENS

In a small apiary where there is any danger to be apprehended from a constant in-breeding, it is a good plan to introduce fresh blood periodically. Or where the old stock is black and it is desired to change to the yellow race, pure Italian queens may be bought from the noted English breeders or obtained direct from the big rearing establishments in Italy.

In either case, the young queen will be received by registered post in what is known as a Benton mailing cage.

The Travelling Cage Method

As will be seen, this is usually a piece of wood about 4 inches by 1¼ inches by 1 inch, with three 1-inch holes bored overlapping and to leave a wall on one side about ¼ inch thick. The other side is covered with wire gauze. At each end a ⅜-inch hole is bored through to the larger holes, thus having communication from one end of the cage to the other. A saw-cut is put along each of the other sides to give ventilation holes.

One of the three circular cavities and one end hole is filled with stiff candy, and a piece of perforated zinc tacked on the outside end. The breeder will have run the young queen into the cage through the lower end hole by picking her off the comb by the wings and putting her head in the right direction. About a score of young bees are added to her in the same way to feed and attend her on the journey. The entrance hole is now covered with zinc or gauze, and the label tacked on the front to protect the bees. The lot is then posted by ordinary registered mail, and, thanks to the candy and the ventilation provided, it arrives in due course to its destination.

On the back of the address label is printed full instructions for the introduction of the queen. The gist of this is that the address card is to be removed, also the piece of zinc covering the end hole which is filled with candy; and, after taking away the old queen from the stock to be operated on, the cage is to be laid on top of the frames and the quilts put on to cover it.

The hive is now to be left absolutely alone for at least forty-eight hours, during which time the bees of the colony will have eaten their way through the candy and will have mixed amicably with the new queen and her workers, who will all find their way out of the cage on to the combs below.

During the forty-eight hours, the new arrivals will have acquired the colony odour and will have been accepted as part of the family.

That is the usual way of introducing a new queen.

The Pipe Cage Method

It has been suggested, however, that in these days of nosema disease, one never knows or feels certain if the guarantee of " healthy " is sufficient to warrant one in taking risks of infection, and that, therefore, it is wiser to kill off all the attendants and introduce the queen by herself, thus reducing the risks to nearly *nil*.

(Parenthetically, it may be remarked here that only once in seventeen years' importation of Italian queens for private use has the author found any disease or defect in the queens, and in that case —to perpetrate a " bull "—it was an imported Carniolan which was infected with, and later died from, nosema disease.)

If it is decided to introduce the queen only, the use of the " pipe-cover " cage made from one of the old-fashioned tea-strainers, or a rectangular cage made by cutting and bending a piece of perforated zinc, is indicated. (See Plate opposite.)

After the old queen is found and removed, a comb is taken out of the hive and the bees all shaken off it. This is carried into the house. The travelling cage is opened and the bees liberated by prying off one end of the wire gauze. The inmates will all fly to the window (which, by the by, must be kept shut for the time being). The queen is picked off the glass by her wings and worked under the cage, which is then fixed firmly to the comb by being pushed down to the mid-rib.

The comb is taken back to its place in the hive and shut down for at least twenty-four hours.

During this time the queen will have got hungry and will have been fed through the gauze by the thronging workers, during the process acquiring the colony odour. At the end of the time, the hive is quietly opened without using smoke, if possible, and if the bees are not excitedly clamouring to get at the queen, but are just calmly awaiting her liberation, the cage may be lifted. If there is no demonstration against her, the comb may be replaced gently and the hive closed down.

If there is the slightest evidence of hostility, cage her again, if possible, with a few newly emerged young bees, and try the operation again after a few hours. If she is accepted, *leave the hive severely alone for a few days.*

This is probably the safest method, but many others are in constant use—old and hoary for the most part.

The Simmins Method

One of the most famous of them—the " Simmins " fasting method—which almost claims infallibility, is a play in three acts.

1. Remove the old queen a few hours before dark.
2. Put the new queen in a matchbox at dusk and keep her warm in your waistcoat pocket, fasting, and quite alone for full thirty minutes.
3. After darkness has set in, gently lift the edge of the quilt (or the glass on a wood quilt),

by lamplight, and let the queen run down into the combs, closing up immediately.

The principle is that, as the queen is hungry, as soon as she meets the workers she holds out her tongue and solicits food instead of getting excited and making the others the same. This is as they expect the mother queen to act, and accordingly they feed and caress her, and all goes well.

The greatest essential of all is to be sure there is neither laying queen, virgin, nor queen cell in the hive at the time of introduction, and, according to Mr. Barrett, the well-known queen-breeder, it is also wise " to be sure there are no larvæ less than four days old."

Mr. Barrett's Method

Mr. Barrett adds to the pipe-cover method the further provision of pushing a pencil through from the other side of the comb, making a hole big enough for the queen's body to pass through. Stop the hole with candy or a rolled up leaf. Replace the comb and leave it alone for three or four days. " This is a positively infallible method," he says.

Many other methods of introduction will be suggested to the experienced man, but for the novice, none is better or safer than those detailed above.

XIV

DATA FOR REFERENCE

Syrup for Spring Feeding may be used even as diluted as two parts of water to one of sugar (by volume).

Syrup for Autumn Feeding

Sugar (granulated white), 5 lb.
Water, 2 imperial pints or $2\frac{1}{2}$ lb. weight
Tartaric acid, $\frac{1}{4}$ teaspoonful (or a tablespoonful of vinegar)

Bring to boil, stirring all the while, and allow to simmer for five minutes.

Candy

Sugar (granulated), 10 lb.
Cream of tartar, 1 teaspoonful
Water, $1\frac{3}{4}$ pints

Stir constantly to prevent burning until all the sugar is dissolved, then bring to boil and allow to continue for exactly three minutes. Remove from the fire and set in a bath of cold water for a few minutes. Now stir vigorously with a wooden spoon

until it whitens like thin gruel, then pour into moulds.[1]

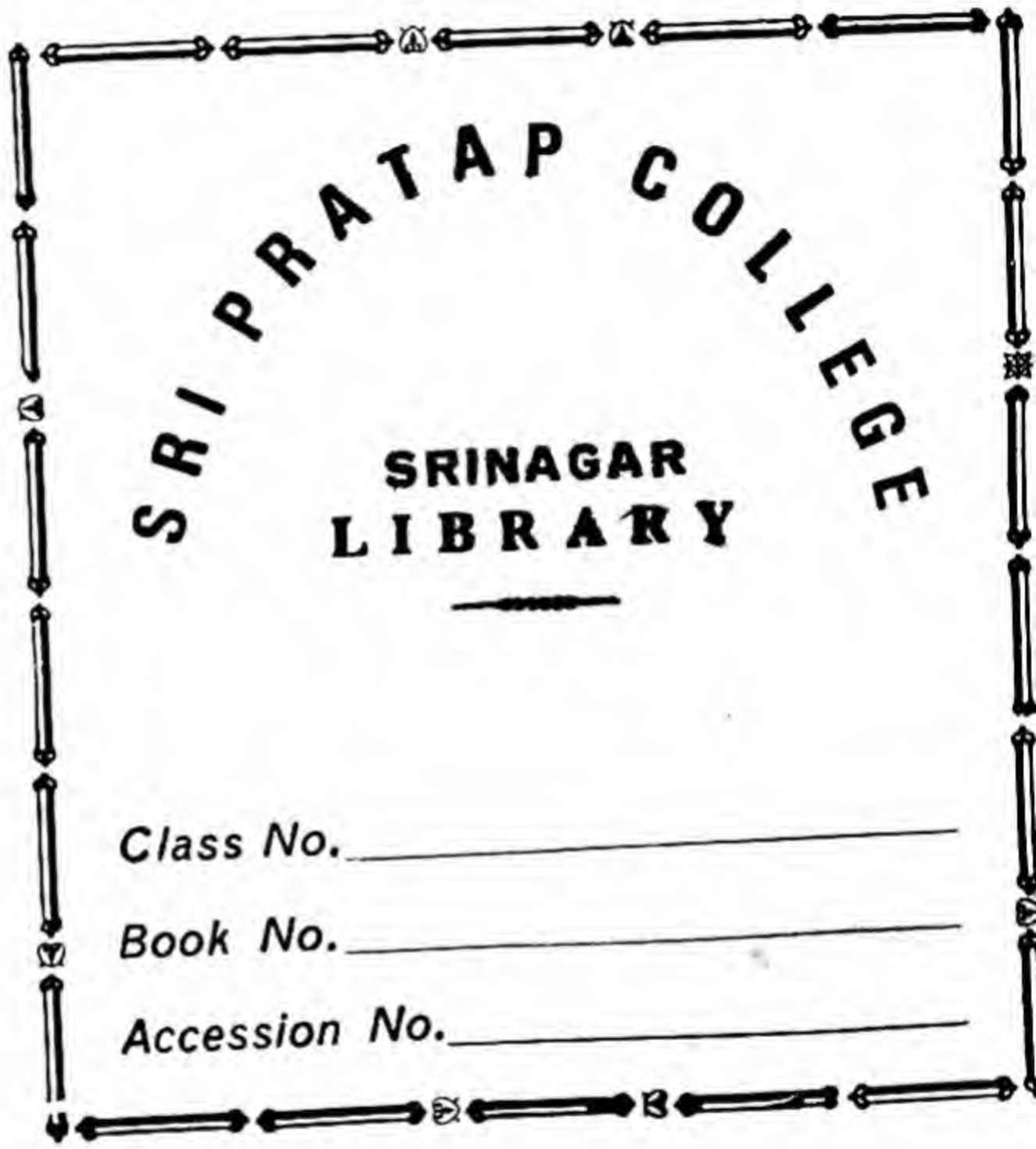
ANOTHER RECIPE FOR CANDY

3 lb. sugar
½ pint water
Cream of tartar (as much as will stand on a 6d. piece)

Put in a brass or enamelled pan and heat until dissolved, stirring continuously. Then place on fire and bring to boil. Boil for exactly two minutes. Remove from fire and stand in cold water until syrup begins to cloud. Stir well and pour into moulds.

When set, it should be a moist, solid mass easily cut with the finger-nail.

[1] NOTE.—The best moulds in the writer's experience are the shallow glass dishes in which imported ox tongues and spiced beef are sold. They are convenient to use above the feed-hole of the wood quilt, and it is easy to see when they need replenishing.



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BOOKS TO READ AND BE REFERRED TO BY THE UP-TO-DATE BEE-KEEPER

Bee-Keeping

Practical Bee-Keeping. A. M. STURGES, B.Sc. 10s. 6d.
Bee-Keeping. DR. PHILLIPS. 13s.
Productive Bee-Keeping. F. C. PELLETT. 11s. 6d.
Bee-Keeping for All. TICKNER EDWARDS. 3s. 6d.
Modern Bee-Keeping. HERBERT MACE, F.E.S. 5s.
Swarm Control and Comb Honey Production. A. M. STURGES, B.Sc. 1s. 6d.

Anatomy

Practical Bee Anatomy. ANNIE D. BETTS, B.Sc. 3s. 6d.

History of Bee-Keeping

The Lore of the Honey Bee. TICKNER EDWARDS. 2s. 6d.

Queen-Rearing

Queen-Rearing in England. F. W. L. SLADEN.
Productive Queen-Rearing. F. C. PELLETT. 5s. 4d.

Periodicals

The Bee World (most modern, scientific, and international).
British Bee-Keepers' Journal.
The American Bee Journal.
Gleanings in Bee Culture.

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